NIKE-HERCULES TECHNICAL DATA

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HIPAR DESCRIPTIVE DATA (U)

TRANSMITTER SYSTEM	EFS HIPAR	EFS RETROFIT HIPAR	ATBM HIPAR
PRF	400 to 445 pps (fixed with moving target indicator (MTI) trigger)	Same	Same
Frequency range	1350 to 1450 mc (ten preset crystal-controlled frequencies, selected at battery control console or transmitter control cabinet)	Same	Same
Transmitter Tube type	Broadband Klystron Type ~~ZU-6001~~ 6803 L	Same	Same
Peak power	~~7.5~~ 10.4 megawatts	5.5 megawatts	~~7.5~~ 10.4 megawatts
Average power	~~19~~ 26 kilowatt (.00254 duty cycle)	14 kilowatts (.00254 duty cycle)	~~19~~ 26 kilowatts (.00254 duty cycle)
Pulse width	6 μsec	Same	Same
Transmitter frequency change time	Less than 90 μsec (During dead time before transmitted pulse)	Same	Same
TR tube			
Recovery time	Less than 100μsec to 3 db down point	Same	Same
Insertion loss	0.7 db maximum	Same	Same
Duplexer tube			
Recovery time	105 μs	Same	Same
Insertion loss	0.3 db maximum (transmitting) 0.1 db maximum (receiving)	Same	Same

RECEIVING SYSTEM			
Receiver type	Low-noise broadband parametric amplifiers of the lower sideband, up-converter type (noise figure limit is 3 db) dual channel (main and auxiliary)	Same	Same
System noise figure (including front-end loss and sky noise)	5.5 db (maximum - either channel) 4.5 db (typical)	Same	Same

NIKE-HERCULES TECHNICAL DATA

RECEIVING SYSTEM	EFS HIPAR	EFS RETROFIT HIPAR	ATBM HIPAR
Receiver bandwidth (Target channel)	200 kc	Same	Same
Receiver bandwidth (Strobe channel)	3 mc	Same	Same
Anti-jam features	Clutter gated noncoherent MTI, Dicke-Fix, Stagger PRF, fast automatic gain control (FAGC) electronic frequency selection	Same	Same
MDS			
Main receiver	-114 dbm	Same	Same
MTI receiver	-112 dbm	Same	Same
Auxiliary receiver	-102 dbm	Same	Same
Parametric amplifier dynamic range			
Main parametric amplifier	80 db	Same	Same
Auxiliary parametric amplifier	80 db	Same	Same
Parametric amplifier gain			
Main amplifier	45 ±3 db	Same	Same
Auxiliary amplifier	45 ±3 db	Same	Same
Image rejection	Spurious signal rejector of 60 db or more at ±10 mc from center frequency	Same	Same
FAGC noise level variation	Less than 2 db at the signal detector for a 60-db variation at the input of the narrowband amplifier with a recovery period of not more than 100 μsec.	Same	Same
STC signal range adjustment	Suppression adjustable from 0 to 80 db (STC time constant adjustable from 100 to 1500 μs) Range adjustable from zero to 40 nautical miles with a reduction of 12 db per octave.	Same	Same

NIKE-HERCULES, IMPROVED NIKE-HERCULES, AND NIKE-HERCULES ATBM MISSILE TRACKING RADAR
HANDWHEEL CONSTANTS AND MAXIMUM TRACKING RATES (U)

Coordinate	Type of Operation: Manual	Aided Manual	Automatic	Slew
ELEVATION	34 mils/turn	0.465 - second time constant; 420 mils/second maximum	700 mils/second maximum	----
AZIMUTH				
A Scope	34 mils/turn	0.313-second time constant; 625 mils/second maximum	700 mils/second maximum	----
RANGE	200 yards/turn	1.15-second time constant; 1000 yards/second maximum	1600 yards/second maximum	18,000 yards/second maximum

MISSILE TRACKING RADAR - DESCRIPTIVE DATA (U)

NIKE-HERCULES

Pulse repetition rate	500 pps (HERCULES mode) 1600-2400 pps (AJAX mode)
Frequency range	8500-9600 mc
Power requirements (minimum)	Average power 79.4 watts Peak power 158.9 kw
Pulse width	0.25 μsec
Frequency tuning rate	50 mc/sec
Antenna type	Double dish cassigranian parabolic reflector consisting of feed, subdish, and polarizing filter
Antenna diameter	92 inches
Antenna gain	
Azimuth and elevation	37.5 db (midband) 2.5 db variation over the frequency band
Sum	44.1 db (midband) 0.7 db variation over the frequency band
Increase over NIKE-AJAX	4.8 db (midband, sum)
Antenna polarization	Vertical
Antenna efficiency	54% (measured/ideal, power gain for uniformly illuminated antenna of same size)
Beamwidth	1 degree azimuth and elevation
Receiver noise figure	11.2 db nominal, with input to converter, (includes noise source correction)
System noise figure	12.2 db nominal with input to converter +1 db preconverter losses (includes noise source correction)
IF preamplifier	
Gain	24 db
Noise figure	3 db

MISSIL E TRACKING RADAR - DESCRIPTIVE DATA (U) (continued)

NIKE-HERCULES

Tracking rates	
Automatic	Azimuth and elevation 700 mils/second maximum range 1600 yards/second maximum
Manual aided	Azimuth and elevation 700 mils/second maximum 1000 yards/second maximum
Slew	Range 18, 000 yards/second
Presentation range	200, 000 yards

NIKE-HERCULES TECHNICAL DATA

Improved NIKE-HERCULES

Pulse repetition rate	500 pps (HERCULES mode) 1600-2400 pps (AJAX mode)
Frequency range	8500-9600 mc
Power requirements (minimum	Average power 79.4 watts Peak power 158.9 kw
Pulse width	0.25 μsec
Frequency tuning rate	50 mc/sec
Antenna type	Double dish cassigranian parabolic reflector consisting of feed, subdish, and polarizing filter
Antenna diameter	92 inches
Antenna gain	
Azimuth and elevation	37.5 db (midband) 2.5 db variation over the frequency band
Sum	44.1 db (midband) 0.7 db variation over the frequency band
Antenna polarization	Vertical
Beamwidth	1 degree azimuth and elevation
Antenna cross-polarized gain	At least 26 db below nominal sum mode gain over the band
Receiver noise figure	11.2 db nominal with input to converter (includes noise source correction)
System noise figure	12.2 db nominal with input to converter +1 db preconverter losses (includes noise source correction)
ATR recovery time (6163 tube)	8 μsec maximum
IF preamplifier	
Gain	24 db
Noise figure	3 db
Receiver dynamic range (including AGC)	Greater than 95 db
Main IF amplifier, gain control range	Greater than 75 db

Tracking antenna capabilities in high winds (based upon 521 ft-lbs to counterwind torque and 7250 lb antenna weight)

TARGET TRACKING RADAR - DESCRIPTIVE DATA (U)

NIKE-HERCULES

Pulse repetition rate	500 pps
Frequency range	8500-9600 mc
Power requirements, minimum	26.9 watts average, 215.3 kilowatts peak
Power requirements, typical	250 kilowatts peak
Pulse width	0.25 μsec
Frequency tuning rate	50 mc/sec
Antenna type	Double dish Cassigranian parobolic reflector consisting of feed, subdish, and polarizing filter
Antenna diameter	92 inches
Antenna gain	
Azimuth and elevation	37.5 db (midband) 2.5 db variation over the frequency band
Sum	44.1 db (midband) 0.7 db variation over the frequency band
Increase over NIKE-AJAX	4.8 db (midband, sum)
Antenna efficiency	54% (measured/ideal, power gain for uniformly illuminated antenna of same size)
Antenna polarization	Vertical
Beam width	1 degree azimuth and elevation
Receiver noise figure	11.2 db nominal with input to converter (includes noise source correction)
System noise figure	12.2 db nominal with input to converter + 1 db preconverter losses (includes noise source correction)
IF preamplifier	
Gain	24 db
Noise figure	3 db
Tracking rates	
Automatic	Azimuth and elevation 700 mils/second maximum; range 1600 yards/second maximum.

Manual aided	Azimuth and elevation 700 mils/second maximum; range 1000 yards/second maximum
Slew	Azimuth 700 mils/second maximum; elevation 62 mils/second maximum; range 18,000 yards/second maximum
Handwheel constants	
Elevation	Manual 34 mils/turn; manual aided 420 mils/second maximum (0.465 second time constant)
Azimuth	Manual 34 mils/turn; manual aided 625 mils/second maximum (0.313 second time constant)
Range	Manual 200 yards/turn; manual aided 1000 yards/second maximum (1.15 second time constant)
Presentation range	200,000 yards

Improved And ATBM NIKE-HERCULES

Pulse repetition rate	400-445 PPS (HIPAR, long and short pulse) 500 PPS (LOPAR, long and short pulse)
Frequency range	8500-9600 mc (X - Band)
Power requirements, minimum	Short pulse 25.1 watts average power, 201.1 kw peak power Long pulse 177.8 watts average power, 142.3 kw peak power
Power requirements, typical	Short pulse 250 kw peak; long pulse 200 kw peak
Pulse width	0.25 and 2.5 μsec
Frequency tuning rate	50 mc/sec
Antenna type	Double dish Cassigranian parabolic reflector consisting of feed, subdish, and polarizing filter
Antenna diameter	92 inches
Antenna gain	
Azimuth and elevation	37.5 db (midband) 2.5 db variation over the frequency band
Sum	44.1 db (midband) 0.7 db variation over the frequency band
Beamwidth	1 degree azimuth and elevation
Antenna cross-polarization gain	At least 26 db below nominal sum mode gain over the band
Antenna polarization	Vertical
Receiver noise figure	10.2 db nominal with input to converter (includes noise source correction)
System noise figure	11.2 db nominal with input to converter + 1 db preconverter losses (includes noise source correction)
Receiver bandwidth	Long pulse, 0.8 mc (bandpass filter) Short pulse, 9.5 mc (main IF amplifier)
ATR recovery time (6163 tube)	8 μsec maximum
IF preamplifier	
Gain	Greater than 25 db
Noise figure	2.30 db
Receiver dynamic range (including AGC	Greater than 95 db
Main IF amplifier, gain control range	Greater than 75 db

Tracking rates	
Automatic	Azimuth and elevation 700 mils/second maximum; range 2600 yards/second maximum
Manual aided	Azimuth and elevation 700 mils/second maximum; range 2000 yards/second maximum
Slew	Azimuth 700 mils/second maximum; elevation 65 mils/second maximum; range 18,000 yards/second maximum
Handwheel constants	
Elevation	Manual 73 mils/turn; manual aided 420 mils/second maximum (1-second time constant)
Azimuth (B Scope)	Manual 440 mils/turn; manual aided 420 mils/second maximum (6-second time constant)
Azimuth (A Scope)	Manual 73 mils/turn; manual aided 420 mils/second maximum (1-second time constant)
Range (B Scope)	Manual 2100 yards/turn; manual aided 2000 yards/second maximum (6-second time constant)
Range (A Scope - long pulse)	Manual 700 yards/turn; manual aided 2000 yards/second maximum (2-second time constant)
Range (A Scope - short pulse)	Manual 175 yards/turn; manual aided 2000 yards/second maximum (0.5-second time constant)
Presentation range	200,000 yards
Tracking antenna capabilities in high winds (based upon 521 ft-lbs to counterwind torque and 7250-lb antenna weight)	
With an inflated radome the tracking antenna will safely operate without fairings in winds up to	75 mph (approx.)
With an inflated radome the tracking antenna will safely operate with fairings in winds up to	90 mph (approx.)
With uninflated radome the tracking antenna is subject to damage in winds exceeding	70 mph
With the radome inflated no damage is sustained in winds up to	100 mph

CHRONOLOGY OF THE NIKE-HERCULES RESEARCH AND DEVELOPMENT PROGRAM

- - - - - 1951 - - - - -

July (5)	Office Chief of Ordnance (OCO) requested feasibility study on the defense against formations of aircraft by use of Corporal in conjunction with T33 or Nike-Ajax system.
July (30)	Conclusions were reached by Bell Telephone Laboratories (BTL) that neither T33 nor Nike-Ajax were feasible to mate with Corporal.

- - - - - 1952 - - - - -

October (9)	Feasibility study requested by OCO for integration of an atomic warhead into the Nike-Ajax missile system. This proposal was considered feasible, with reservations, both for the Nike-Ajax missile and for a larger-diameter missile that would make more efficient use of fissionable materials.

- - - - - 1953 - - - - -

February	Nike-Hercules missile study begun under Nike-Ajax Research and Development (R & D) contract.
March (16)	BTL-OCO conference held to discuss Nike-Hercules Development Program. R & D Board and the Joint Chiefs of Staff had approved the Army requirements for Nike-Hercules.
June (19)	Nike-Hercules program reviewed by Army General Staff G-3 and G-4, Office Chief of Army Field Forces, OCO, Western Electric Co., and Bell Telephone Laboratories at Washington, D. C. Objectives of the Nike-Hercules program were defined as: 1. Development of a new missile to carry a large warhead for use with Nike-Ajax ground guidance and control equipment essentially unmodified. 2. Study of the possibilities of extended range of the Nike-Ajax ground guidance and control equipment to utilize fully the range capabilities of the new missile (including a possible secondary role as a surface-to-surface system).
July (16)	The Nike-Hercules project was authorized by OCO.
October (20 and 21)	Contractor representatives made an oral presentation of the results of Nike-Hercules system studies. Principle topics discussed were:

1. Possible configurations for the Nike-Hercules missile.
2. Ground equipment changes for the 25-mile version of the missile. It was estimated that these changes would cost about 9-1/2 per cent of the original Nike-Ajax ground equipment investment.
3. A long-range (50-mile) version of Nike-Hercules. A cost estimate for the program was given as 21 per cent of the original Nike-Ajax investment.
4. Possibilities of incorporating surface-to-surface capabilities.

- - - - - - 1954 - - - - - -

First Quarter	Authorization given to: 1. Develop a Nike-Hercules missile capable of carrying a 30-inch diameter, 1200-pound payload. 2. Modify a production Nike-Ajax system for testing the 25-mile Nike-Hercules missile at White Sands Missile Range. 3. Continue study on a long-range version of the Nike-Hercules missile.
February (26)	Oral survey of the Nike-Hercules system given by the contractor at the Pentagon Building, Washington, D.C. at the request of the Committee on Guided Missiles of the Department of Defense.
March (23)	A meeting was held at Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland, for the purpose of coordinating the efforts and fixing the responsibilities of the various agencies concerned with the development of the Nike-Hercules cluster warhead.
April (23)	Oral report on surface-to-surface role of Nike-Hercules given to Sergeant Steering Committee.
Second Quarter	Authorization given to: 1. Develop ground equipment models for extended-range (50-mile) version of Nike-Hercules. 2. Continue study of a single-stage solid propellant missile. 3. Investigate the problem of increased accuracy against ground targets.
August (17-20)	Second Nike-Hercules planning conference was held at White Sands Missile Range.
Third Quarter	Authorization given to contractor to construct a second experimental model of the Nike-Hercules ground guidance and control equipment for development use at Bell Telephone Laboratories, Whippany, N.J.

- - - - - - 1955 - - - - - -

January	First R & D firing test.
April (29)	Authorization for five prototype systems.
April (29)	Authorization for Charlotte missile production.

November (30)	Authorization for production of Nike-Hercules ground equipment.
December	Completed preparation of manufacturing information.

White Sands Missile Range Firing Summary

Twenty Nike-Hercules rounds fired with modified Nike-Ajax ground guidance equipment using Bathtub guidance sections.

- - - - - - 1956 - - - - - -

January	First Nike-Hercules missile fired from modified Nike-Ajax R & D system at White Sands Missile Range.
March	Delivery of Nike-Hercules model #1 to White Sands Missile Range.
July (25)	First Nike-Hercules missile fired using a Nike-Hercules missile system.
Third Quarter	First prototype (Santa Monica) missile delivered.
November (30)	First Nike-Hercules prototype system (#1) delivered to BTL.

White Sands Missile Range Firing Summary

Eight firings with modified Nike-Ajax ground equipment.

Four firings with internal programmer.

Fifteen firings with Nike-Hercules ground equipment.

(All firings with Bathtub guidance sections, except two firings with Stovepipe guidance sections. All system test rounds in surface-to-air mode.)

- - - - - - 1957 - - - - - -

January	First prototype (#2) Nike-Hercules system delivered to the Army.
June	Installation of prototype system at White Sands Missile Range.
June (30)	First production system delivered to the Army.

White Sands Missile Range Firing Summary

QB-17 drone kill, 2/6/57, 9000-foot altitude MSL, 20,000-yard range.

QF-80 drone kill, 4/25/57, 9000-foot altitude MSL, 25,000-yard range.

QB-17 drone kill, 9/11/57, 6300-foot altitude MSL, 50,000-yard range.

First solid propellant missile, 3/13/57.

First production-type missile fired, 7/12/57, with Nike-Hercules prototype system #1.

First successful surface-to-surface round, 8/21/57.

First low altitude round, 9/11/57.
(Drone destroyed by direct contact.)

First article inspection round, 11/27/57.

Four surface-to-surface rounds (three successful).

Four low-altitude rounds (two successful).

Five T45 warhead rounds.

Six cellular launcher tests.

- - - - - - 1958 - - - - - -

January	Delivery of first production (Charlotte) missile.
June	First tactical deployment.

White Sands Missile Range Firing Summary

Three surface-to-surface rounds (all successful).

First flight test of Charlotte production missile successful (also first article inspection round), 4/30/58.

First T46 warhead round, 4/2/58.

First live T46 warhead round, 6/25/58.

Project Ammo demonstration round successful, 7/1/58.

Series of eight rounds to demonstrate in-flight reliability — five fired from White Sands Missile Range, three fired from McGregor range, (seven successful) 7/58.

First Mushroom guidance section flight, 8/8/58, (successful).

Army Ordnance Association demonstration round, 10/9/58.

First flight against POGO drone successful, 11/6/58, 109,000-foot altitude MSL, 58,000-yard range, T45 warhead (drone killed).

First flight against Q-5 drone successful, 11/19/58, 60,000-foot altitude, 50,000-yard range, T45 warhead (drone killed).

- - - - - 1959 - - - - -

January	HIPAR model at Whippany operational.
	Snowjet cold weather operational tests (Fort Churchill, Manitoba).
February	Experimental Dicke-Fix receivers (ECCM devices) installed in Washington-Baltimore Defense Area.
April	Ordnance Design Characteristics Inspection of the Improved NIKE-HERCULES System.
May	Testing of Mobile Launcher model begun at White Sands Missile Range.
June	Quick Reaction Capability Program initiated to introduce electronic counter-countermeasure devices into NIKE systems on an expedited basis.
July	Analysis of Weapons System Evaluation Group Test No. 3 to evaluate NIKE performance in a heavy ECM environment presented to ARGMA.
October	Complete Improved NIKE-HERCULES System model at Whippany operational.
November	Development started as part of the HERCULES program on a multichannel ECCM receiver known as the Anti-Jam Display (AJD).

White Sands Missile Range Firing Summary

Two low-altitude rounds successfully fired at a grounded B-17 aircraft carcass for evaluation of the T-46 warhead, 1/7/59.

First flight against Matador drone successful, 2/6/59, 42,500-foot altitude, 48,000-yard ground range, T-45 warhead (drone killed).

QF-80 drone successfully intercepted at an altitude of less than 1000 feet, 2/18/59, 25,900 yard ground range, T-45 warhead (drone killed).

Flight against POGO-Hi target successful, 3/11/59, 156,000-foot altitude, 19,000-yard ground range, T-45 warhead (target killed).

Four rounds fired to demonstrate T-46 warhead tactical capability, 5/59 to 9/59 (all successful).

First firing from cellular launcher, 6/24/59 (successful).

Series of 16 successful rounds to demonstrate surface-to-surface capability — 9 fired from White Sands Missile Range, 7 fired from McGregor range, 7/59 to 9/59.

First round fired to test Transponder Control Group parachute recovery system, 8/28/59 (successful).

Q-5 drone flying at Mach 2.2 successfully intercepted, 10/16/59, 38,000-foot altitude, 47,000-yard ground range.

- - - - - 1960 - - - - -

February	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW I.
March	Proposed concept of mobility for the High Power Acquisition Radar (HIPAR) of the Improved NIKE-HERCULES System was prepared.
March	Anti-Jam Display (AJD) equipment installed in the S-band Acquisition Radar (LOPAR) at Whippany and tested in an ECM environment.
March	Whippany Improved NIKE-HERCULES Model operated as a Basic NIKE-HERCULES System participated in SIOUX ARROW II.
March	Prototype HIPAR accepted with the Improved NIKE-HERCULES Ground Guidance System by Army Ordnance (3/31/60).
April	Study on Cross-Country NIKE-HERCULES indicated feasibility to mount the Improved NIKE-HERCULES System on self-propelled, Goer-type vehicles.
April	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW III.
April	Study completed which investigated the capabilities of the Basic and Improved NIKE-HERCULES System with certain modifications against attack by certain short-range ballistic missiles. (4/8/60).
April	First firings made from the prototype Improved NIKE-HERCULES System at White Sands Missile Range (4/14/60).
May	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW IV.
June	Study made of an abbreviated NIKE-HERCULES System limited only to the surface-to-surface mode of operation.
June	Whippany Improved NIKE-HERCULES Model participated in SIOUX ARROW V.
July	Installation and checkout of the Manual Anti-Jam Display (AJD) for the Whippany Improved NIKE-HERCULES Model and the White Sands Missile Range Prototype HIPAR concluded.
November	Study concerning the feasibility of using a single HIPAR to supply acquisition data to a dual NIKE-HERCULES site completed.
December	Model kit for experimental installation of the MARK XII. IFF Interrogation System to selected NIKE-AJAX and NIKE-HERCULES Systems completed.

White Sands Missile Range Firing Summary

HERCULES Missile (B-281) cold condition to -40°F. successfully intercepted a POGO Target. (2/5/60).

Four rounds (B-284, 285, 286, 293) fired in evaluation tests of the new low-altitude functions which were installed in the C-Station Computer. Three rounds were successful. One unsuccessful. (2/26/60, 2/26/60, 3/2/60, 4/26/60).

First firings from ZURF occurred; one AJAX Missile (660) fired in a successful system test of ZURF. (3/8/60). One HERCULES round (ZURF) also fired. (4/8/60)

Two firings (B-294, ZURF-6) made using cold-conditioned missiles. One successful intercept of a simulated target was made at 130,000 yards range, 64,000 feet altitude MSL. The other round unsuccessful. (5/17/60, 7/15/60).

AJAX missile successfully fired to evaluate miss distance indicator to be used in the HIGHBALL target program. (5/21/60)

First intercept by HERCULES missile (INH-2), equipped with a conventional T-45 warhead, of a CORPORAL missile at 26,500 feet MSL and a range of 52,000 yards. (6/3/60)

HERCULES (INH-4) intercepted a POGO-HT Target at an altitude of 101,000 feet MSL and a ground range of 52,000 yards. (6/15/60)

Six separate HERCULES missiles (INH-3,6,8,9,11,12) fired against six target HERCULES missiles. (6/15/60, 8/12/60, 8/17/60, 9/14/60, 10/6/60, 11/17/60)

Three HERCULES rounds (B-299, B-303, B-305) fired for the T-46 firing program. (7/6/60, 7/27/60, 10/12/60)

HERCULES missile (INH-5) successfully intercepted a Q-5 drone at 63,000 feet MSL and 72,000 yards ground range. (7/11/60)

HERCULES missile (INH-7) fired at a surface target 115,000 yards up-range. (8/17/60)

HERCULES missile (INH-10) successfully destroyed an XM-21 drone at the low altitude of 4500 feet above ground level. Ground range was 60,000 feet. (9/14/60)

- - - - - 1961 - - - - -

	First quarter Strategic Air Command (SAC) developed a Radar Bomb Scoring field kit for use in NIKE Systems.
January	HIPAR operating frequency band shifted from 1435 - 1535 MCS to 1427 - 1527 MCS.
January	The design of Electronic Shop 3 (GS-58679) for the Improved NIKE-HERCULES Battery Type IV was placed into production.
February	Whippany Model HIPAR modified to incorporate automatic Anti-Jam Display (HAJD) capability.
May	Army Rocket and Guided Missile Agency requested that Bell Telephone Laboratories develop an Anti-tactical Ballistic Missile (ATBM) system.
June	Feasibility study for operating one HIPAR with two NIKE-HERCULES Systems resulted in a modification kit to provide facilities for integrating a HIPAR into NY-49, a dual Improved NIKE-HERCULES site.

1/AV - FINALIZED ECP'S - TM'S

November The "A" Frame Derick for use with the NIKE-HERCULES Field Army System mounted and tested.

November Testing of the Improved NIKE-HERCULES HIPAR Anti-Jam Display (HAJD) successfully completed.

White Sands Missile Range Firing Summary

Six HERCULES missiles (SS-1 thru SS-6) fired in support of a surface-to-surface evaluation. (2/28/61 to 4/27/61)

HERCULES (INH-15) successfully intercepted Q2A drone at 4500 feet above terrain, 52,000 yards range. (3/10/61)

HERCULES round (INH-16) fired in the surface-to-surface mode to 100,000 yards ground range (3/21/61).

First GOER launch (B-314) at simulated ASM. (3/30/61)

HERCULES (INH-17) with T-45 successfully intercepted ECM-equipped Q2A drone at 27,000 feet above terrain, 96,000 yards range. (4/31/61)

Simulated radar-seeking missile target successfully intercepted by a HERCULES Missile (B-316) at 52,000 feet MSL and 58,000 yards ground range. (5/20/61)

Round (B-317) fired at a space point, 15,000 feet MSL and 30,000 yards ground range during verification that failsafe switches at station 136 would operate correctly. (6/14/61)

First firings from a GOER launcher in the surface-to-surface mode. Two missiles (B-320, 321) fired to a ground range of 154,000 yards. (9/20/61, 10/6/61).

L-5-1

HERCULES (INH-13) launched and successfully intercepted an ECM-Equipped XM-21 Drone at 22,000 feet MSL and 60,000 yards ground range. (11/17/61)

HERCULES round (INH-18) equipped with a Miss Distance Indicator (MDI) successfully intercepted a ballistic HIGHBALL II Rocket nose section at an altitude of 20,000 feet (MSL) and ground range of 54,000 yards. (11/20/61)

HERCULES round (INH-19) with T45 warhead fired against a Redstone missile under "Operation HARDNOSE." Intercept of the REDSTONE nose cone not accomplished. (12/5/61) Lost Beacon?

System Test Division (STD) Round 84HE successfully fired at a 66-foot diameter polyethylene balloon. (12/6/61)

ATBM – Two HERCULES missiles (ZURF-13, 14) fired at space points as high altitude ballistic targets for NIKE-ZEUS System Demonstrations (12/12/61, 12/14/61)

- - - - - 1962 - - - - -

March AOMC authorized the development of the Cross-Country NIKE-HERCULES HIPAR Program (3/6/62).

March The HIPAR staggered PRF modification concluded.

FEB- GE ROLL-OUT AT PLANT 4" SNOW

April	General Electric began development of mobile HIPAR.
April	Static ECCM tests for the TRR completed and documented. (4/16/62)
June	Prototype Evaluation of the Improved NIKE-HERCULES System completed and documented.
June	Criteria established for an acceptable Cross-Country NIKE-HERCULES power distribution system. (6/26/62)
June	The Improved NIKE-HERCULES System implemented with the "Sync-loop" successfully beacon-tracked ZEUS missiles. (6/28/62, 7/31/62, 8/28/62)
July	The EFS modification installed in the prototype NIKE-HERCULES System at WSMR.
August	Two brassboard kits of the lin-log receivers installed in the Prototype Improved NIKE-HERCULES System at WSMR for dynamic testing.
September	Ordnance documentation for ATBM System completed and approved by AMICOM. (9/28/62)
September	Production model of the ATBM modification (less HIPAR) installed in the improved NIKE-HERCULES Prototype System at WSMR. (9/22/62) 1ST KIT 1
November	Installation of ATBM HIPAR Antenna into the Improved NIKE-HERCULES Prototype System at WSMR complete. LC-37 AUG 62
December	Development effort to provide Cross-Country capability to the NIKE-HERCULES System discontinued. (12/13/62).
December	Interim Mobile HIPAR proposed. (12/15/62)

White Sands Missile Range Firing Summary

Two HERCULES cold rounds (B-324, 325) successfully fired at space points. (1/12/62, 2/9/62)

System Test Division (STD) round 85HE successfully fired in the SS mode. (1/29/62)

STD round (FS-4) successfully fired at a 36-foot metalized parachute. (3/15/62)

HERCULES missile (ZURF-15) fired as high altitude ballistic targets from ZURF for NIKE-ZEUS System demonstrations. (3/28/62)

HERCULES missile (B-326) successfully fired in the SS mode at a target 154,000 yards distant. (5/12/62)

For evaluation of a new guidance section two HERCULES rounds (B-327, 328) fired on special "roller coaster" trajectories. The rounds were successfully fired at a test point 20,070 yards in range and zero altitude. (6/28/62, 8/16/62)

A HERCULES missile (B-330) and two special missiles successfully fired at a space point. Maximum altitudes attained were 280,000, 228,000, and 320,000 feet MSL respectively. (9/10/62, 8/28/62, 8/29/62)

- - - - - 1963 - - - - -

February	Advanced HERCULES study program begun by BTL at the request of AMICOM.
February	Effort terminated on development of the NIKE-HERCULES GOER solid state power converter. (2/15/63)
March	NIKE-HERCULES participated in Project DOMINIC.
April	BTL study on the NIKE-HERCULES Proposed Improvement Program was documented. (4/17/63)
April	Design requirements on Interim Mobile HIPAR finalized. (4/19/63)
April-May	Flight Tests conducted to evaluate HIPAR MTI Performance.
May	Design of vans for use with Mobile HIPAR completed.
June	Contractor directed by HERCULES Project Office at RSA to develop specific improvements to TTR, TRR, and HIPAR and conduct feasibility studies on an improved Battery Control Console and use of scan conversion.
July	R and D model of "Random/Program Frequency Selector" installed in the HIPAR at WSMR.
August	HIPAR Electronic Frequency Selection (EFS) modification kit installed in the WSMR HIPAR.
November	Design requirements for the Interim Mobile HIPAR finalized and released.

White Sands Missile Range Firing Summary

Instrumented HERCULES cold round (B-331) successfully fired at two space points 80,000 feet MSL, 130,000 yards ground range and 43,000 feet MSL, 167,000 yards ground range. (1/18/63)

A HERCULES round (B-332) fired at a surface target of 154,000 yards ground range to evaluate new missile guidance section components. Missile fail-safe at 123 seconds. (2/7/63)

The first missile (ATBM-1) of the NIKE-HERCULES ATBM Prototype System fired at a NIKE-HERCULES missile launched from the ZURF site. Event recorder miss distance was 738 feet. (4/3/63)

The nose section of a Pershing missile tracked after being released from a B-47. (5/17/63)

The second missile (ATBM-2) of the Prototype NIKE-HERCULES ATBM System intercepted a POGO target at an altitude of 101,000 feet MSL and a ground range of 30,000 yards. (5/11/63)

Four HERCULES missiles (ATBM-3, -4, -5, -8)fired from the HERCULES ATBM Prototype System against HERCULES target missiles. (5/17/63, 5/28/63, 6/5/63, 6/5/63)

Two HERCULES missiles (ATBM-6, -7) fired from the HERCULES ATBM Prototype System successfully intercepted a space point at a ground range of

80,000 yards and an altitude of 120,000 feet MSL. (6/26/63, 7/19/63)

A HERCULES missile (ATBM-9) with a T-45 warhead fired from the HERCULES ATBM site and successfully intercepted a HERCULES target missile at a ground range of 56,000 yards and an altitude of 65,000 feet. This was an Engineering/Service tactical firing test and was conducted by a military operating crew. (9/5/63)

HERCULES missile (ATBM-11) with a T-45 warhead successfully fired from the ATBM site against a REDSTONE missile. Intercept occurred at 45,000 yards ground range and an altitude of 40,000 feet MSL. (10/5/63)

Two HERCULES missiles (ATBM-12 and 13) successfully fired from a mobile launcher located 1000 yards from the MTR. (10/11/63 and 10/24/63)

First SERGEANT intercept by HERCULES (ATBM-14). (12/9/63)

HERCULES missile (ATBM-15) with a T-45 warhead fired against SERGEANT target missile. (12/18'63)

- - - - - 1964 - - - - -

March	The HIPAR portion of the ATBM Prototype Test Program at WSMR completed.
April	Douglas report prepared which described the technical and economic aspect of converting to a single-stage missile.
May	Development phase of the Mobile HIPAR program completed.
June	HIPAR MTI performance investigation completed and documented.
March	Contractor testing of Interim Mobile HIPAR System completed.
April	Implementation of AJD into WSMR EFS/ATBM HIPAR begun.
April	Modifications begun to increase radiated power of HIPAR transmitter.

White Sands Missile Range Firing Summary

First TECOM tactical SERGEANT intercept by HERCULES (ATBM-17). Intercept occurred at an altitude of 40,600 feet (MSL)and a ground range of 60,000 yards. (1/15/64)

First intercept of HONEST JOHN by HERCULES (ATBM-18) Intercept at 23,000 yards ground range, altitude 20,700 feet (MSL) (1/21/64)

First TECOM tactical HONEST JOHN intercept by HERCULES (ATBM-19). Intercept at 21,000 yards ground range, altitude 24,000 feet (MSL). (1/30/64)

NIKE-HERCULES

PROPELLANT CHARACTERISTICS

LETTER REPORT RD-PR-87-40

ROBERT R. RADKE

JULY 1987

PROPULSION DIRECTORATE
RESEARCH, DEVELOPMENT, AND ENGINEERING CENTER
U. S. ARMY MISSILE COMMAND
REDSTONE ARSENAL, ALABAMA

ME/MK✓

I. Propellant Properties.

A. Booster Propellant.

1. Designation: OIO

2. Composition.

Nitocellulose (12.6% N)	59.1
Nitroglycerin	25.3
Glycerol Triacetate	9.5
Dimethyl Phthalate	2.6
Lead Stearate	1.9
2-Nitro Diphenyl Amine	1.6

3. Combustion Properties.

Molecular Weight	22.84
Pressure	14.70 psia
Temperature	3243.0 F
Ratio of Specific Heats	1.24

M30

B. Sustainer Propellant.

1. Designation: TP-E-8082

2. Composition.

Ammonium Perchlorate	62.98
Ethyl Formal Polysulfide	33.17
Para Benzoquinone Dioxime	2.32
1,3-Diphenyl Guanidine	1.16
Polymeric Amide	0.33
Sulfur	0.04
	100

3. Combustion Properties.

Molecular Weight	24.23
Pressure	14.70 psia
Temperature	3245.0 F
Ratio of Specific Heats	1.19

II. Exhaust Species.

A. The theoretical booster exhaust products that were considered are expressed in mole fraction.

1. Free elements.

a. Greater than 0.000005 mole fraction.

H	0.00102
PB	0.00055

b. Less than 0.000005 mole fraction.

C N O

2. Gasses.

a. Greater than 0.000005 mole fraction.

CO	0.44667
CO2	0.08782
H2	0.18835
H2O	0.17488
N2	0.10060
OH	0.00010
PBO	0.00001

b. Less than 0.000005 mole fraction.

CH	C2H2	HCN	NO
CH2	C2H4	HCO	NO2
CH2O	C2H6	HNCO	N2H4
CH3	C2N	HNO	N2O
CH4	C2N2	HO2	N2O4
CN	C2O	H2O2	N3
CNN	C3	NCO	O2
CN2	C3O2	NH	O3
C2	C4	NH2	
C2H	C5	NH3	

3. Liquids.

a. Greater than 0.000005 mole fraction.
None

b. Less than 0.000005 mole fraction.
H2O

4. Solids.

a. Greater than 0.000005 mole fraction.
None

b. Less than 0.000005 mole fraction.
C H2O

B. The theoretical sustainer exhaust products that were considered are expressed in mole fraction.

1. Free elements.

a. Greater than 0.000005 mole fraction.

CL	0.00052
H	0.00105
S	0.00077

b. Less than 0.000005 mole fraction.

C N O

2. Gasses.

a. Greater than 0.000005 mole fraction.

CO	0.22652
COS	0.00073
CO2	0.06038
CS	0.00001
HCL	0.12936
H2	0.19540
H2O	0.24612
H2S	0.01714
N2	0.07135
OH	0.00014
SH	0.00451
SO	0.00559
SO2	0.01259
S2	0.02782

b. Less than 0.000005 mole fraction.

CCL	CN	C2H2	CLCN	H2O2	N2O
CCL2	CNN	C2H4	CLO	NCO	N2O4
CCL3	CN2	C2H6	CLO2	NH	N3
CCL4	COCL	C2N	CL2	NH2	O2
CH	COCL2	C2N2	CL2O	NH3	O3
CH2	CS2	C2O	HCN	NO	SN
CH2O	C2	C3	HCO	NOCL	SO2CL2
CH3	C2CL2	C3O2	HNCO	NO2	SO3
CH4	C2H	C4	HNO	NO2CL	
		C5	HO2	N2H4	

3. Liquids.

a. Greater than 0.000005 mole fraction.

None

b. Less than 0.000005 mole fraction.

H2O S

4. Solids.

a. Greater than 0.000005 mole fraction.

None

b. Less than 0.000005 mole fraction.

C H2O S

Control Fins. (Delta planform, 2.78% thick, double-wedge airfoil, maximum thickness at 59.2% chord, hinge lines of both pairs of fins are same distance aft of body nose.)

Over-all span	24.598 in
Span at trailing edge, one fin	7.576 in
Root chord (theoretical at body centerline)	28.975 in
Tip chord	0.000 in
Chord at fin-fuselage intersection	20.307 in
Hinge line location, distance forward of trailing edge	8.076 in
Theoretical vertex angle at body centerline	46.000 deg
Gross area, two fins	2.475 ft^2
Mean aerodynamic chord of gross area	19.317 in
Exposed area, two fins	1.068 ft^2
Mean aerodynamic chord of exposed area	13.538 in
Maximum deflection	±15.0 deg

Radar Antenna Fairings. (Four triangular-shaped fairings located at Station 72.000 in the planes of the main fins.)

Span (measured from tip to fuselage)	3.000 in
Chord at antenna-fuselage intersection	10.350 in

Conduit Fairings. (Four approximately semicircular fairings extending from Station 17.272 to Station 230.750, equally spaced around the circumference of the missile between the fins.)

Width at base	3.625 in
Maximum extension above fuselage	1.250 in

AJAX
BOOSTER

Fins. (Trapezoidal, 6.13% thick root and 6.57% thick tip, double-wedge airfoil, maximum thickness at 50.0% chord.)

Circular span	86.325 in
Span at trailing edge, one fin	34.688 in
Root chord (intersection with skin)	37.125 in
Tip chord	10.500 in
Angle of sweepback of leading edge	20.996 deg
Angle of sweepback of trailing edge	-20.996 deg
Exposed area, one fin	5.736 ft^2
Mean aerodynamic chord of exposed area	26.306 in

BOOSTER (continued)

Motor

Beginning of head assembly	Sta 257.437
Beginning of cylindrical section	Sta 262.037
Centerline of fins	Sta 373.562
End of nozzle exit	Sta 392.125
Diameter at end of head pad	18.760 in
Diameter of cylindrical section	16.400 in
Diameter of end of nozzle	16.626 in
Internal diameter of nozzle exit (approximate)	16.636 in

134.688

Thrust Structure

Forward end of structure	Sta 233.187
Aft end of structure	Sta 257.437
Aft end of missile	Sta 251.000
Diameter of structure (forward external)	15.250 in
Diameter of structure (forward internal)	12.031 in
Diameter of structure (aft internal)	9.031 in
Circular span of structure	19.187 in
Booster impact cushion	Sta 251.218

THRUST

Booster M5

Rated vacuum thrust (approximate)	59,000	lb
Duration (approximate)	3.5	sec
Total impulse (approximate)	147,500	lb sec

Missile

Nominal thrust (sea level)	2600	lb
Duration (approximate)	20.8	sec

WEIGHT

Missile AJAX

Gross weight	1193.3	lb
Expendable load:		
Oxidizer (red fuming nitric acid)	241.8	lb
Starting propellant	1.9	lb
Fuel (83% JP4 gasoline and 17% UDMH)	50.5	lb
Air	17.1	lb

WEIGHT (continued)

M5

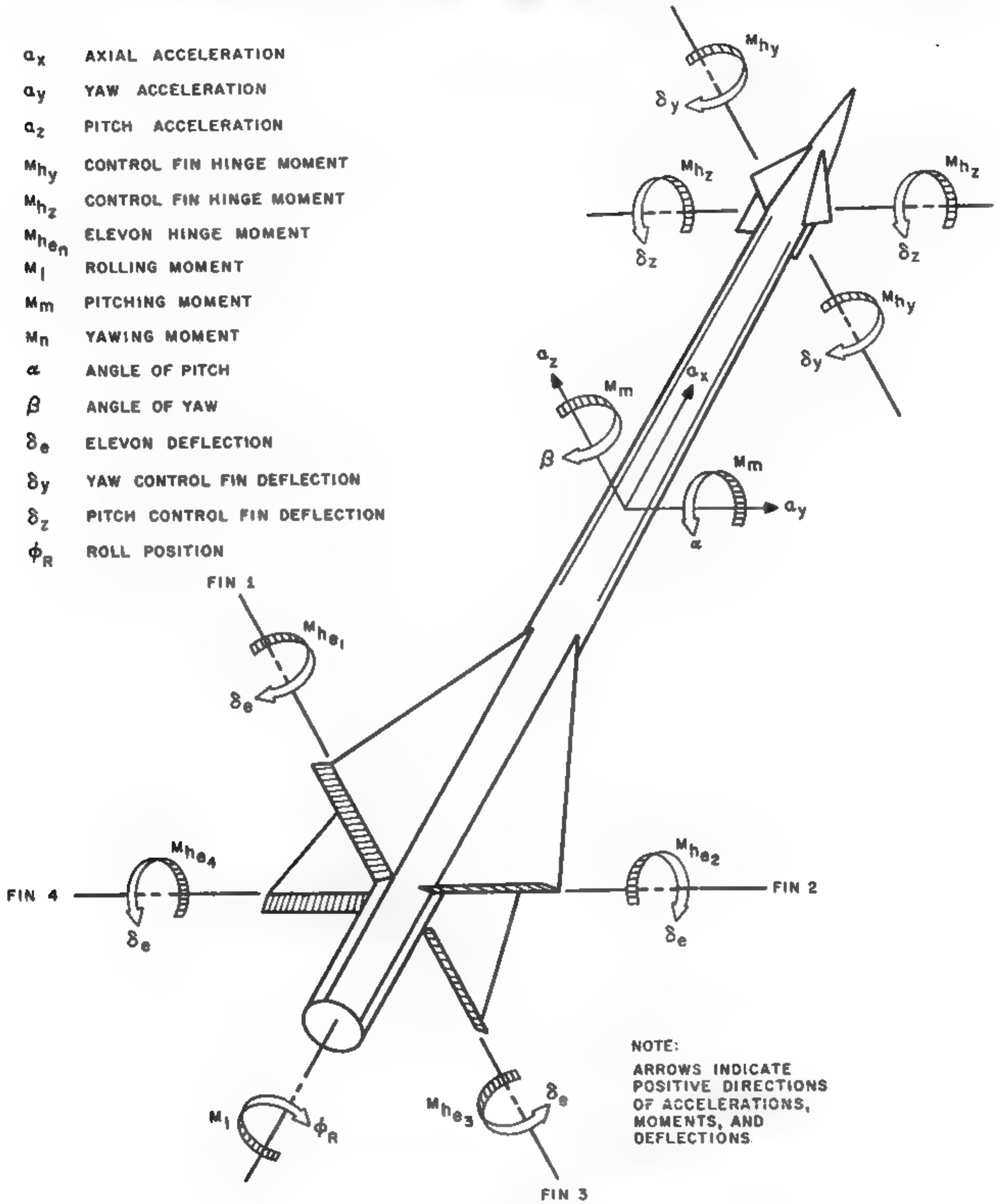
Booster.

Gross weight	1306	lb
Propellant	750.5	lb
Igniter and disk assembly	4.0	lb
CG loaded	Sta 316.5	
CG empty	Sta 322.0	

AJAX

Missile-Booster Combination.

Gross weight	2499.3	lb
Missile gross weight plus empty booster	1744.8	lb
CG at firing	Sta 231.54	
CG at end of boost	Sta 196.54	



NIKE-AJAX SIGN CONVENTIONS
(Accelerations, Moments, and Deflections)

DESCRIPTION OF NIKE-HERCULES MISSILE

The NIKE-HERCULES configuration is a two-stage, ground-to-air vehicle consisting of a solid propellant, computer-controlled missile connected through a thrust structure to a cluster of four solid propellant boosters. The missile was designed to carry a payload of 1200 pounds.

The missile body has an over-all length of 322.5 inches and a maximum diameter of 31.5 inches. The nose section is of ogival shape, fairing to a constant section at Station 136. The tapered section begins at Station 247.5 and tapers to a diameter of 21.2 inches at the base. The missile contains four wings of delta planform having root chords of 182.64 inches and a gross span of 88.0 inches. Linearizer fins of delta shape and exposed semispans of 8.496 inches are attached to the body immediately forward of its intersection with the leading edge of each wing. Elevons for controlling both steering and roll are hinged to the trailing edge of each wing, separated from the wings by an air gap. The elevons have trapezium planforms and chords which average 8.230 inches. Four radar antenna fairings are located at the aft edge of the forward fins at approximately Station 87 and are an integral part of the linearizer. This installation also incorporates the ram pressure tubes.

The booster cluster is attached to the missile through a thrust structure 33.187 inches in length and having a circular span of 43.3 inches at its aft end. The base of the missile rests in the structure 7.312 inches forward of its aft end. The over-all length of the booster cluster, including the thrust structure, is 170.845 inches; each individual booster has a constant outside diameter of 16.4 inches. The booster cluster is enclosed at its aft end by a shroud 28.3 inches long, having a cross-sectional width of 34.8 inches. Four fairing plates extend from the forward end of the shroud to the fin leading edge and body intersection. Four fins of trapezoidal planform are attached at the aft end of the booster cluster. These fins have root chords of 45.0 inches, tip chords of 23.4 inches, and a gross span of 137.9 inches.

The missile-booster combination is connected to the launcher by means of two sets of lugs located on the booster cluster, one at Station 333 and the other at Station 447, and one lug located on the missile at Station 150.

The four M-5 boosters have a total nominal rated thrust of 173,600 pounds and have a nominal duration of 3.4 seconds at 77°F. The XM30 solid propellant motor is actuated by an ignitor engine which produces a 1000-pound thrust for 0.3 second. The ignitor engine is actuated by a thermal battery which provides a delay of 0.7 second to prevent motor start from occurring before the missile clears the booster thrust structure at separation. The propellant consists of an ethyl rubber fuel and an ammonium perchlorate oxidizer. The power plant produces a nominal thrust of approximately 13,750 pounds for 29 seconds at 70°F.

1 = 43,400 LBS THRUST
3.4 Sec

DESCRIPTIVE DATA, NIKE-HERCULES

MISSILE

Fuselage

Over-all length	322.500 in
Distance from nose tip to:	
Linearizer fin leading edge-body intersection	47.50 in
Linearizer fin trailing edge	85.20 in
End of ogival nose section	133.50 in
Start of boattail section	245.00 in
Trailing edge of wing tip	285.13 in
Hinge line of elevon	287.50 in
Trailing edge of elevon	293.250 in
Diameter of cylindrical section	31.50 in
Maximum cross-sectional area	779.31 in^2
Diameter of base	21.19 in
Cross-sectional area of base	352.59 in^2

Wings. (Delta planform, 2.20% thick at root chord, modified double-wedge airfoil, maximum thickness at 83.2% of root chord, aspect ratio 0.604.)

Gross span	88.00 in
Chord at fin, maximum body intersection	182.64 in
Tip chord	0.00 in
Semiapex angle of body centerline	8.60 deg
Angle of trailing edge sweepback	8.33 deg
Exposed area of two panels outboard of chord at fin-maximum body intersection	5159.30 in^2
Mean aerodynamic chord (MAC) of exposed area	121.76 in
Maximum thickness	5.00 in
Leading edge radius	0.63 in
Trailing edge thickness	0.20 in

Elevons. (Trapezium planform, modified double-wedge airfoil section, 5.83% thick at average chord line, aspect ratio 4.04.)

Gross span at trailing edge	90.453 in
Exposed semispan	32.364 in
Average chord	8.230 in
Root chord	9.911 in
Sweepback angle of leading edge	6.31 deg

MISSILE (continued)

Elevons (continued)

Area of one elevon	259.272 in^2
Area aft of hinge line	183.682 in^2
Leading edge radius	0.015 in
Maximum thickness of average chord	0.480 in

Linearizer Fins and Antenna Fairings. (Delta planform, aspect ratio of exposed fin 0.45, modified double-wedge airfoil section, maximum thickness line swept 45°.)

Gross span	41.838 in
Exposed semispan	8.496 in
Length of fin-body intersection	37.959 in
Theoretical semiapex angle at body centerline	18.92 deg
Exposed area (one panel)	160.150 in^2

M42A1 - 1337-00-891-5470 (9020717)
M42E2 1337-00-646-7324 (8525883)

BOOSTER M42

Booster Body. (Cluster of four Radford M-5 boosters.)

Over-all length (including thrust structure)	170.845 in
Length of shroud	28.25 in
Distance from base of thrust structure to:	
Leading edge of shroud	106.50 in
Trailing edge of fins	137.66 in
Cross-sectional width of shroud	34.75 in

Thrust Structure

Distance from forward end of structure to base of missile	25.875 in
Length of structure	33.187 in
Outside diameter at forward end of structure	33.06 in
Circular span at aft end of structure	43.25 in
Thickness of impact cushion	0.50 in

Booster Fins. (Trapezoidal planform, 6.18% thick at root chord, double-wedge airfoil, maximum thickness at 49.4% of root chord, taper ratio 52%, aspect ratio 0.7.)

Gross span (including body)	137.88 in
Fin-body intersection chord	45.00 in
Tip chord	23.40 in
Exposed area (one panel)	1641.60 in^2
Mean aerodynamic chord of exposed area	35.34 in
Leading edge sweepback angle	24.23 deg

BOOSTER (continued)

Booster Fins (continued)

Trailing edge sweepback angle	0.00 deg
Exposed semispan	48.00 in
Maximum thickness	3.06 in

THRUST

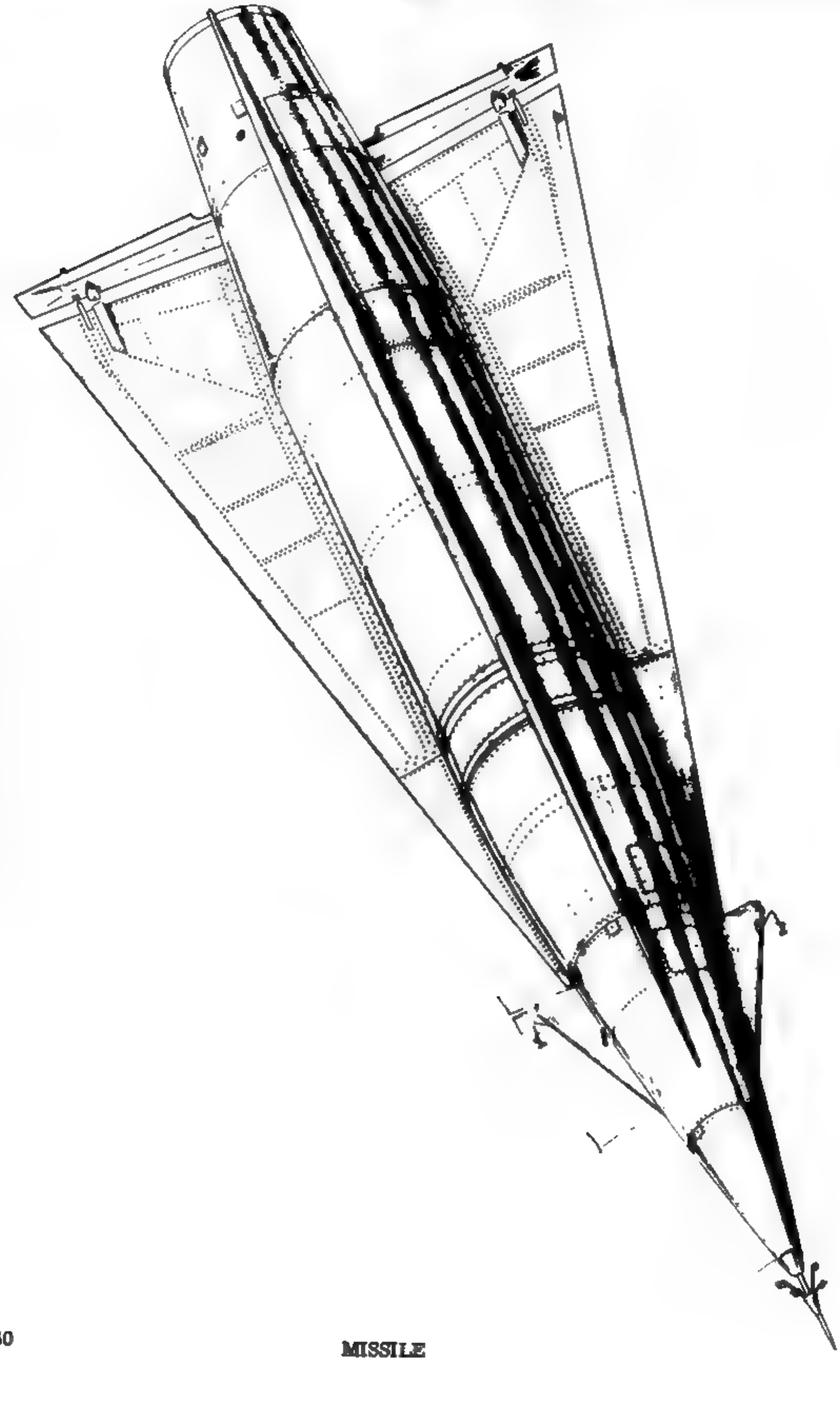
Booster. (Cluster of four Radford M-5 boosters.)

Rated vacuum thrust (nominal) at 77° F	43,400	173,600 lb
Duration (nominal) at 77° F		3.4 sec
Total impulse (nominal) at 77° F		600,000 lb sec

Missile. (JATO XM-30.) M30A2 1337-00-832-5102
A1 1337-00-965-0830

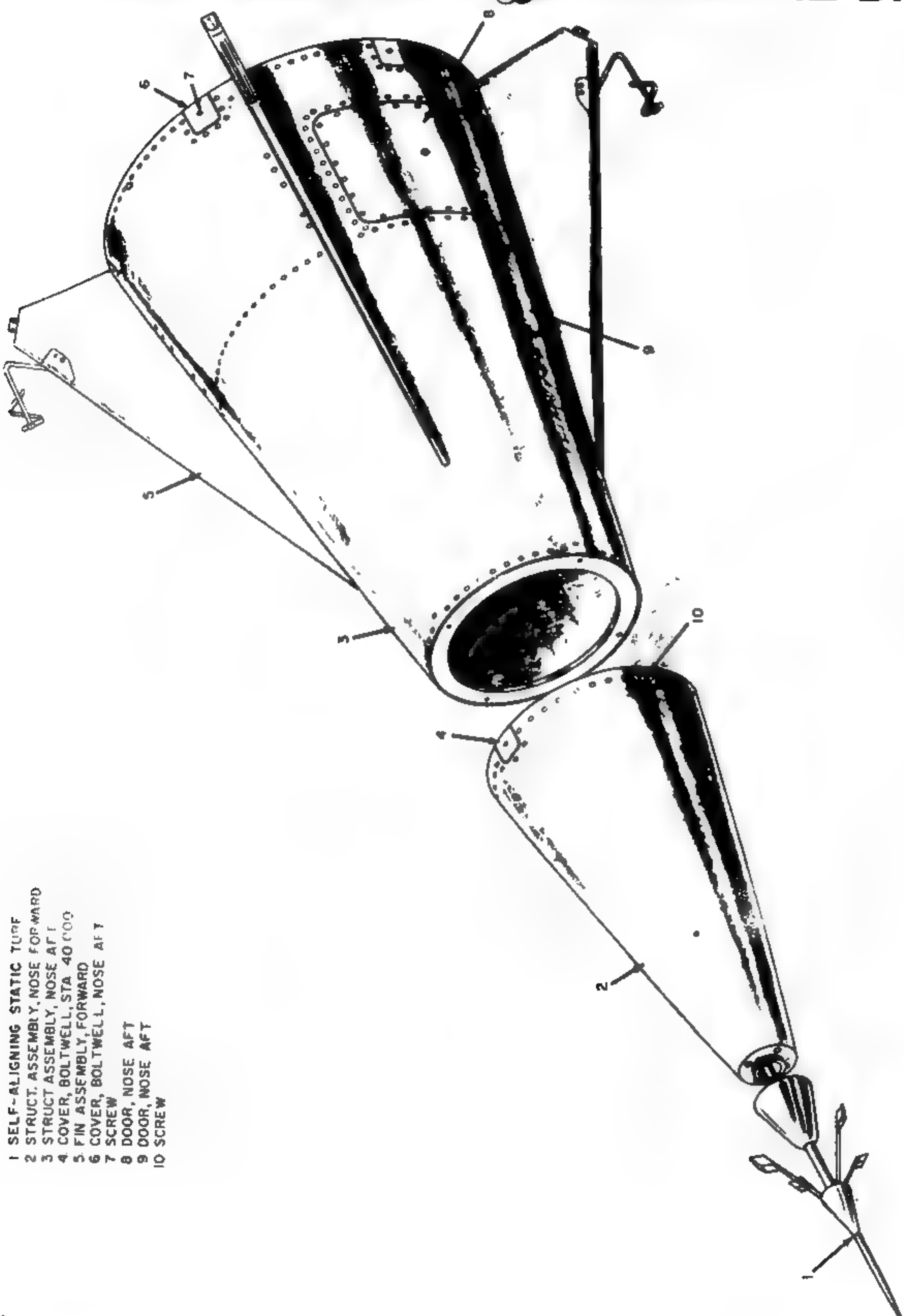
Rated thrust (sea level) at 70° F	13,750 lb
Duration (nominal) at 70° F	29 sec
Total impulse (nominal) at 70° F	388,500 lb sec

NIKE-HERCULES MISSILE, ILLUSTRATED LIST



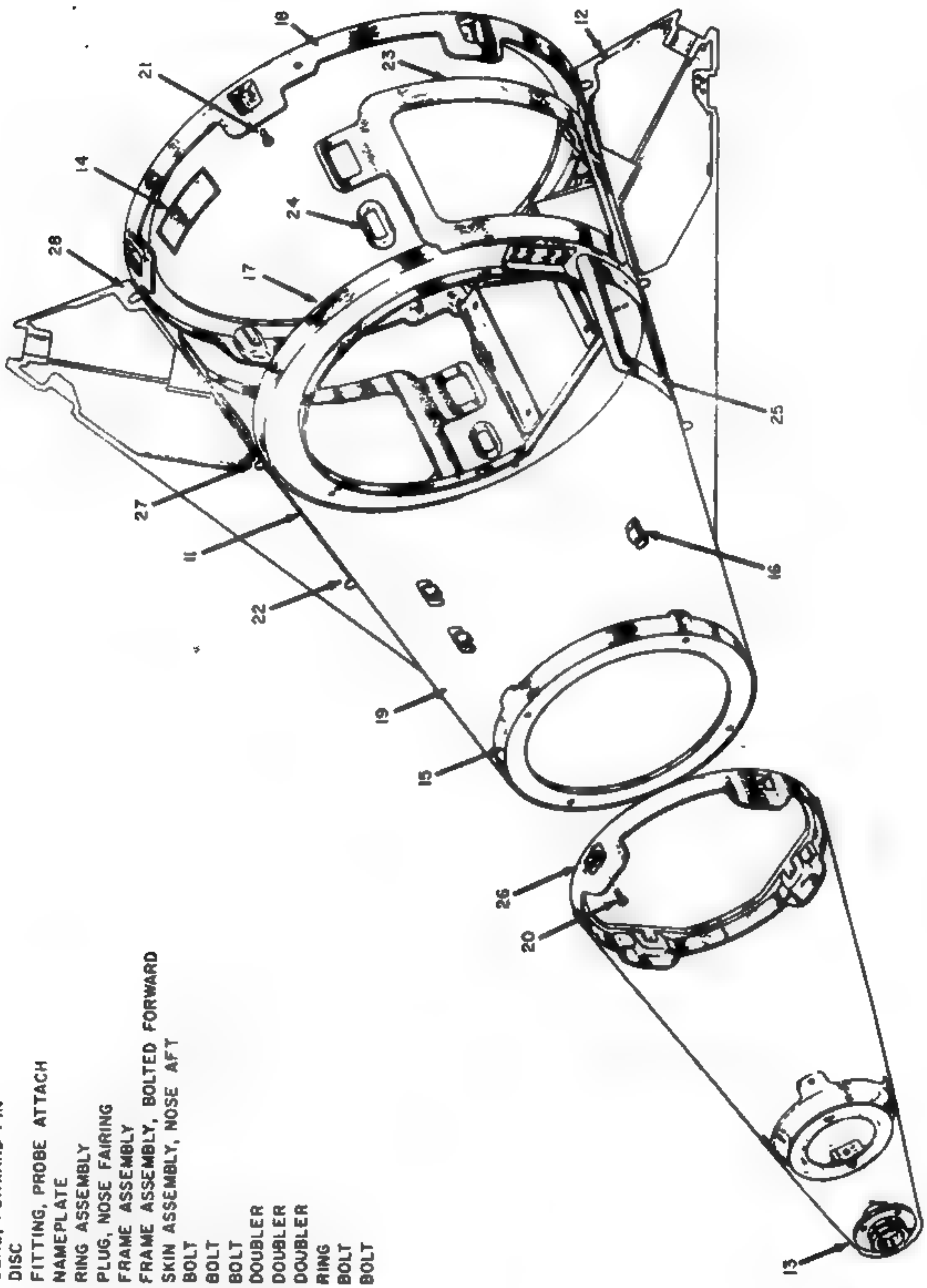
COMPLETE MISSILE

1028313 8524287
1034849 8521061



1 SELF-ALIGNING STATIC TUBE
2 STRUCT. ASSEMBLY, NOSE FORWARD
3 STRUCT ASSEMBLY, NOSE AFT
4 COVER, BOLTWELL, STA 40.000
5 FIN ASSEMBLY, FORWARD
6 COVER, BOLTWELL, NOSE AFT
7 SCREW
8 DOOR, NOSE AFT
9 DOOR, NOSE AFT
10 SCREW

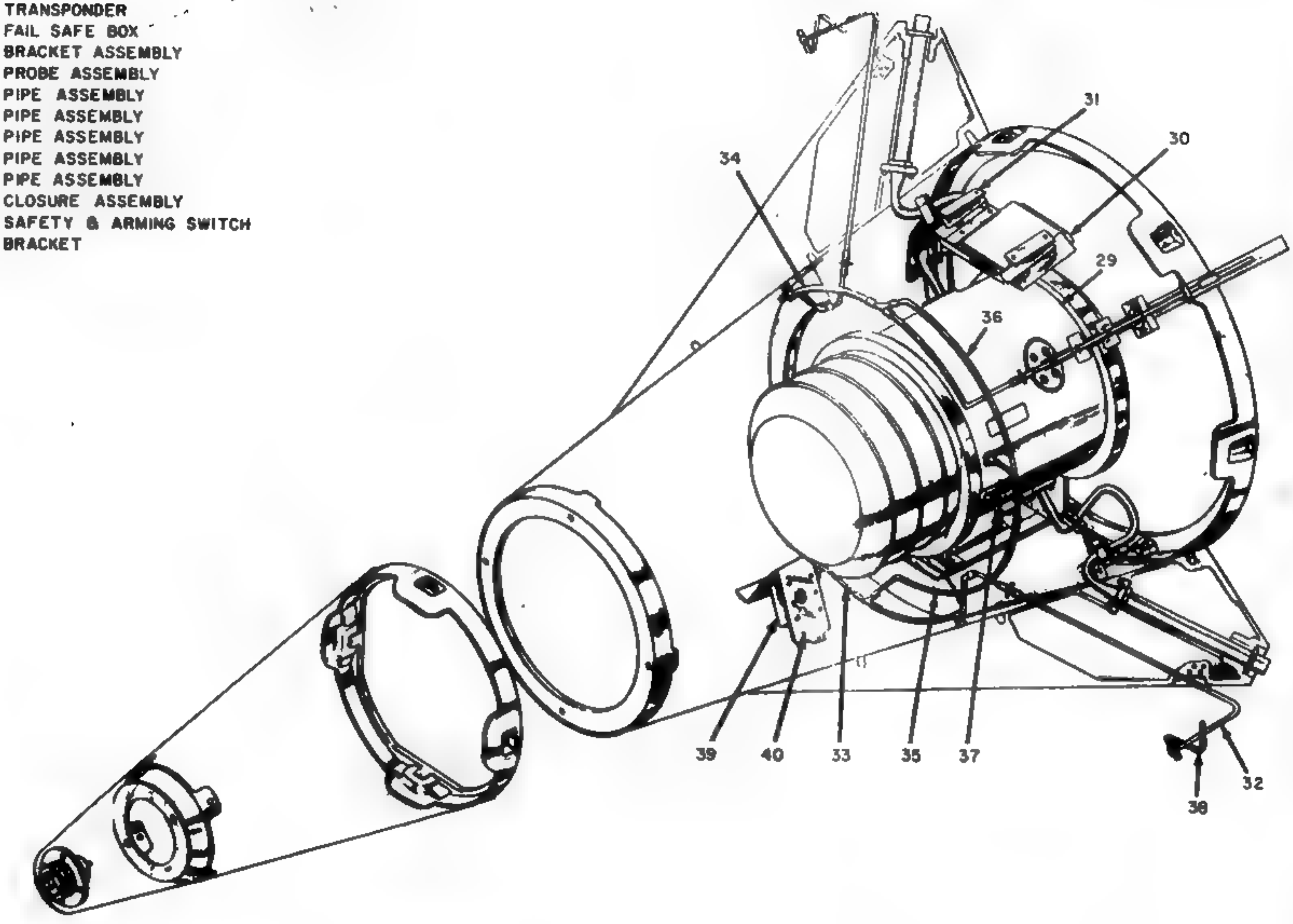
FORWARD BODY ASSEMBLY



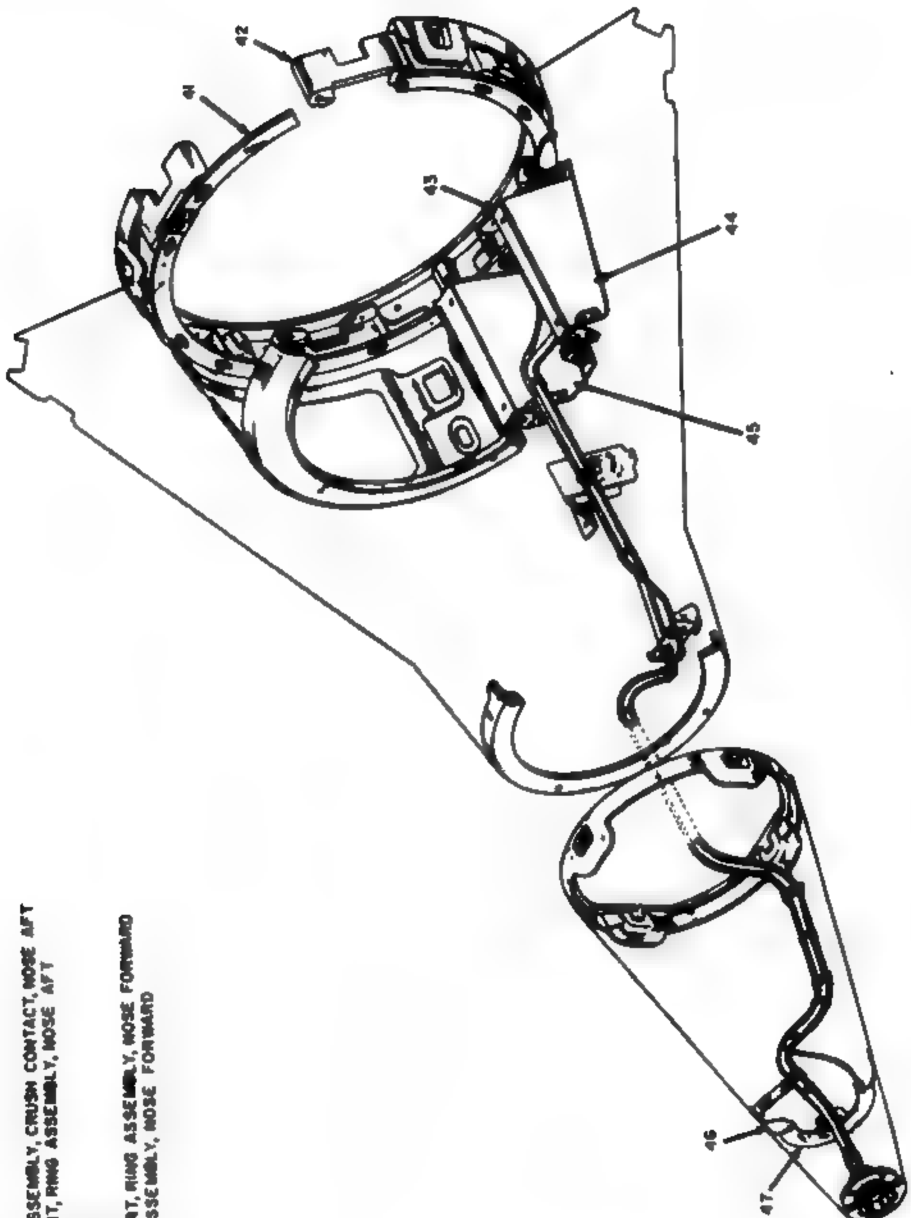
11. SEAL, FORWARD FIN
12. DISC
13 FITTING, PROBE ATTACH
14. NAMEPLATE
15 RING ASSEMBLY
16 PLUG, NOSE FAIRING
17. FRAME ASSEMBLY
18 FRAME ASSEMBLY, BOLTED FORWARD
19. SKIN ASSEMBLY, NOSE AFT
20 BOLT
21. BOLT
22 BOLT
23 DOUBLER
24 DOUBLER
25 DOUBLER
26 RING
27. BOLT
28. BOLT

NOSE STRUCTURE ASSEMBLY

29. TRANSPONDER
30. FAIL SAFE BOX
31. BRACKET ASSEMBLY
32. PROBE ASSEMBLY
33. PIPE ASSEMBLY
34. PIPE ASSEMBLY
35. PIPE ASSEMBLY
36. PIPE ASSEMBLY
37. PIPE ASSEMBLY
38. CLOSURE ASSEMBLY
39. SAFETY & ARMING SWITCH
40. BRACKET

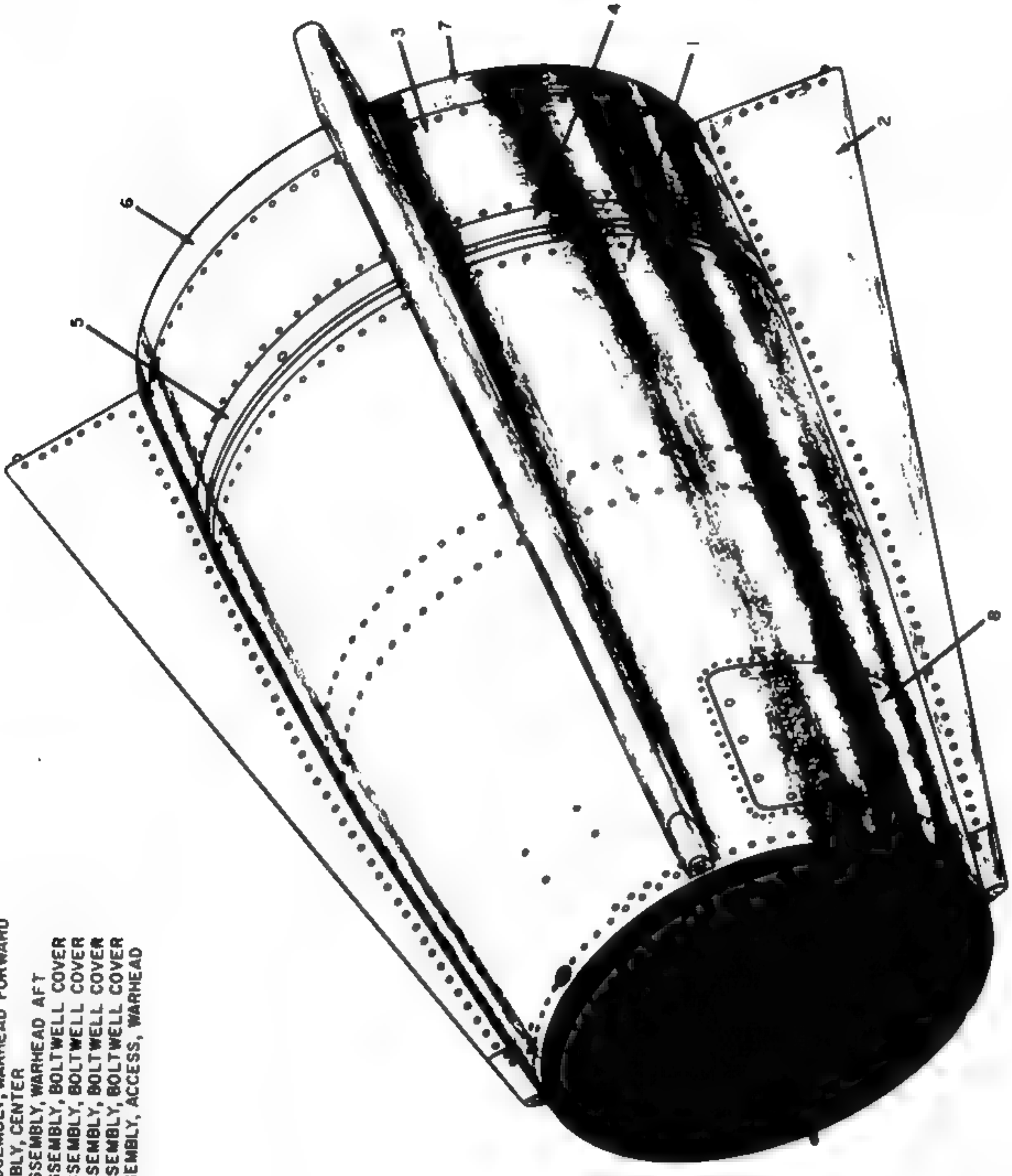


GUIDANCE SET EQUIPMENT INSTALLATION



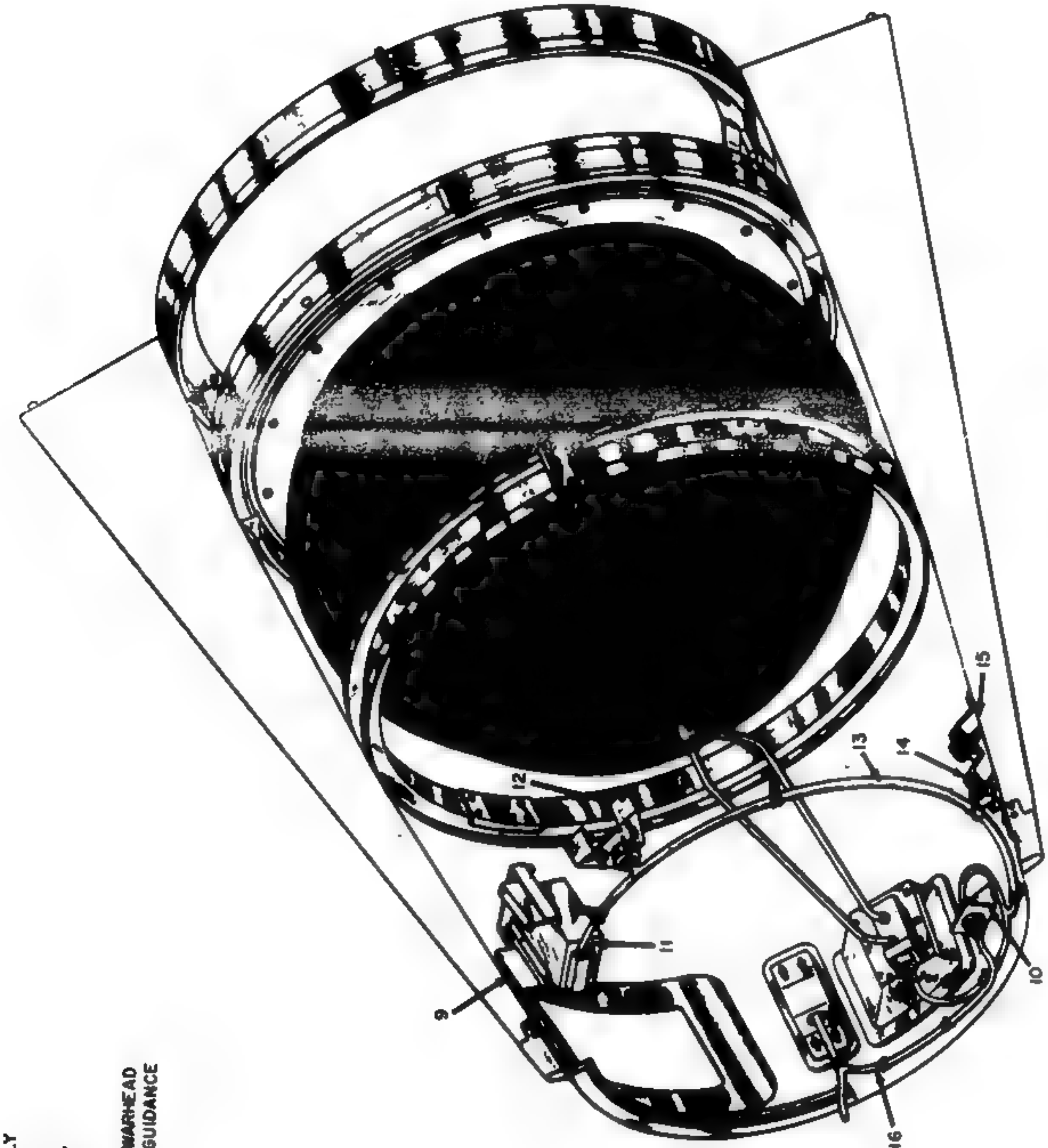
41 RING ASSEMBLY, CRUSH CONTACT, NOSE AFT
42 SUPPORT, RING ASSEMBLY, NOSE AFT
43 GUIDE
44 MOUNT
45 MOUNT
46 SUPPORT, RING ASSEMBLY, NOSE FORWARD
47 RING ASSEMBLY, NOSE FORWARD

CRUSH RING AND PRESSURE HOSE INSTALLATION



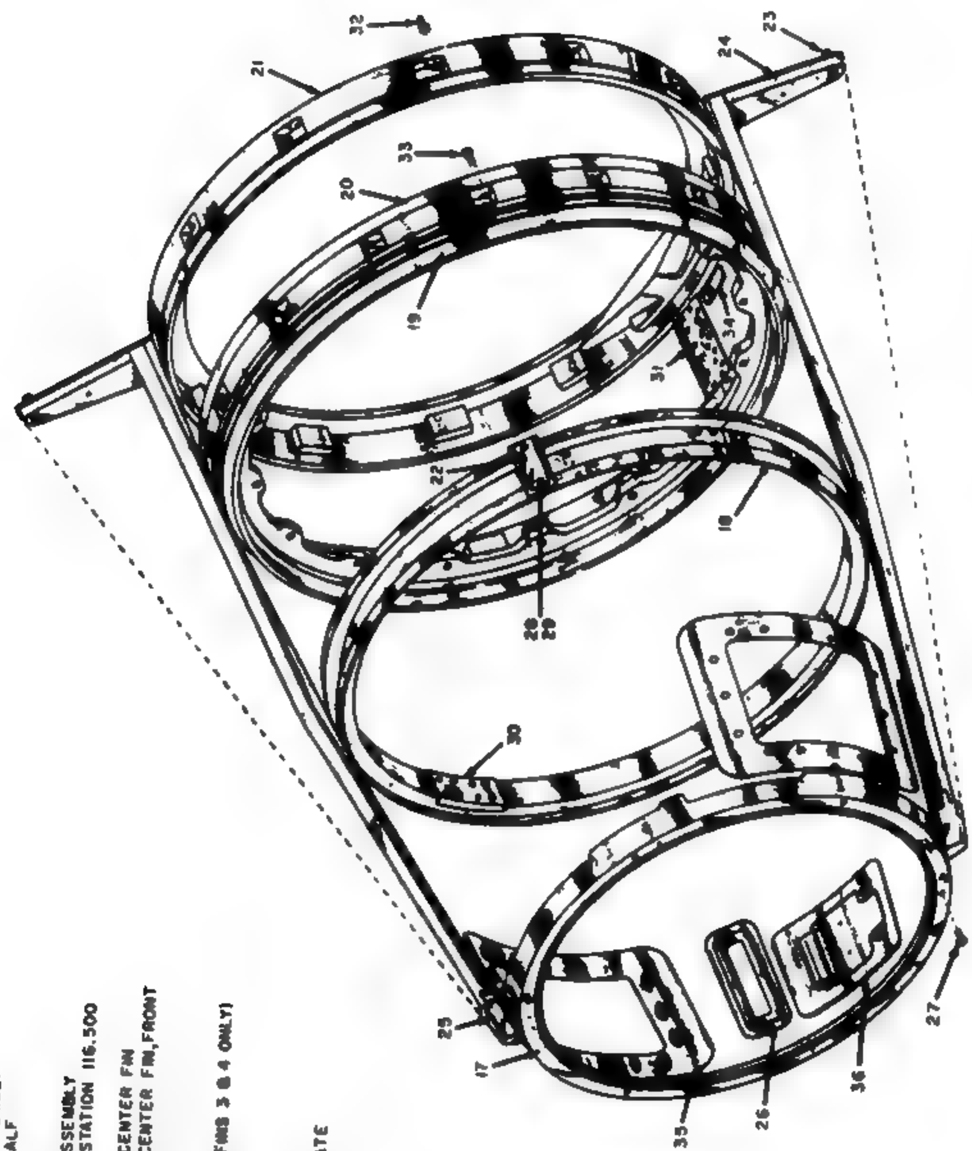
WARHEAD BODY ASSEMBLY

1. STRUCT ASSEMBLY, WARHEAD FORWARD
2. FIN ASSEMBLY, CENTER
3. STRUCT. ASSEMBLY, WARHEAD AFT
4. FAIRING ASSEMBLY, BOLTWELL COVER
5. FAIRING ASSEMBLY, BOLTWELL COVER
6. FAIRING ASSEMBLY, BOLTWELL COVER
7. FAIRING ASSEMBLY, BOLTWELL COVER
8. COVER ASSEMBLY, ACCESS, WARHEAD



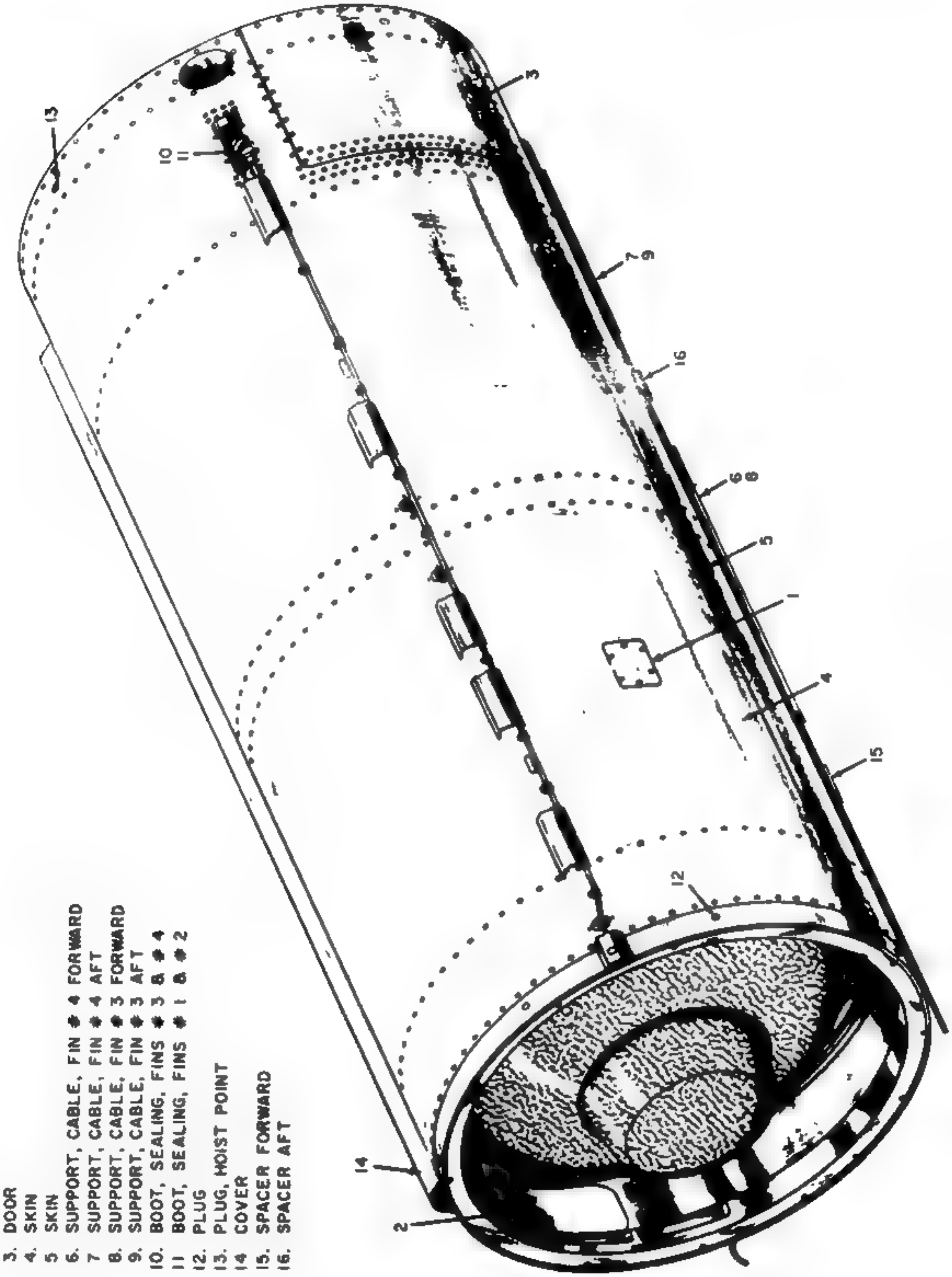
WARHEAD EQUIPMENT INSTALLATION

9 BRACKET ASSEMBLY
10. BRACKET
11. FAIL SAFE BOX
12. JUMPER ASSEMBLY
13 CABLE ASSEMBLY
14 BRACKET
15. CABLE ASSEMBLY WARHEAD
16. CABLE ASSEMBLY GUIDANCE



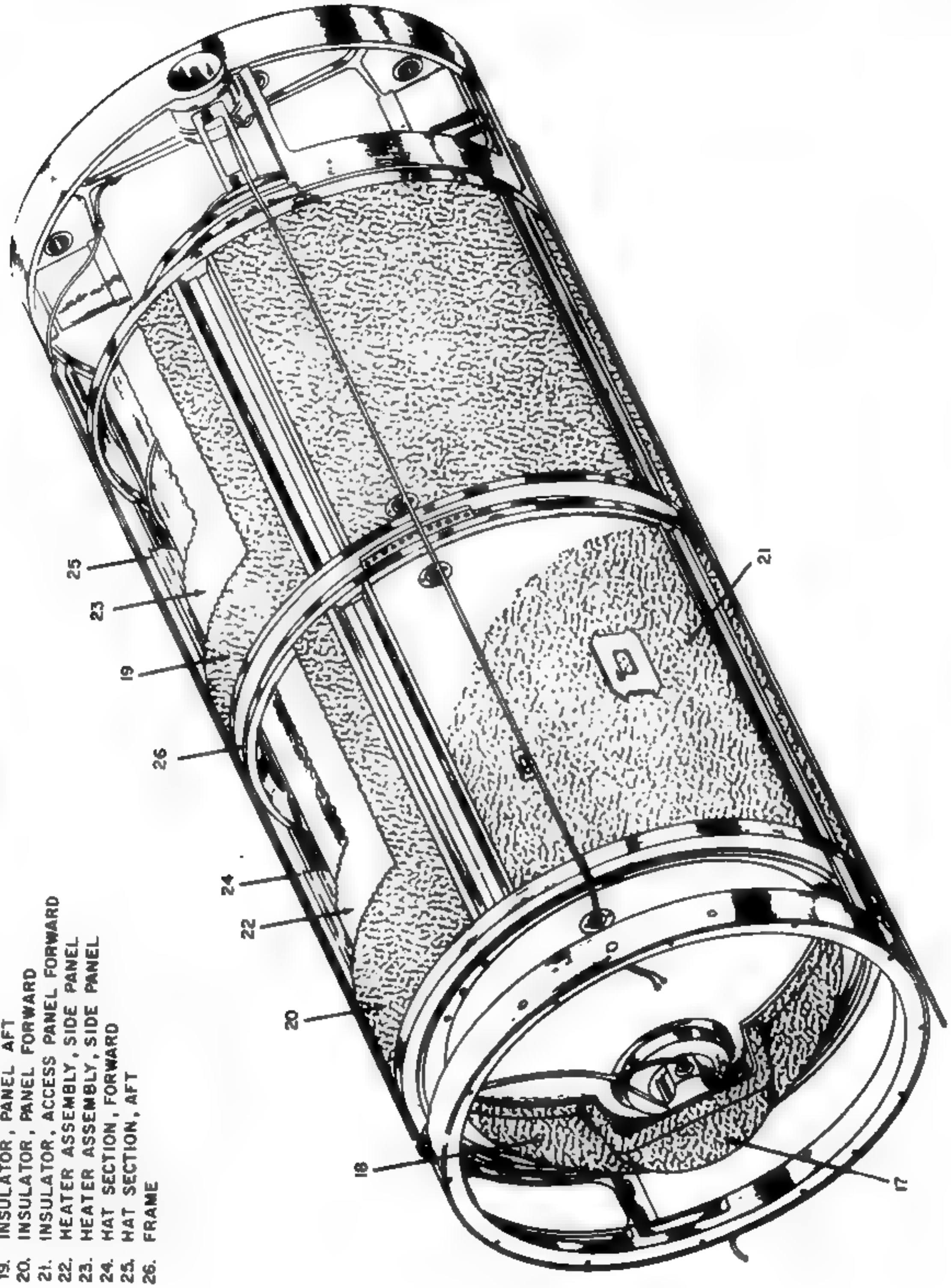
WARHEAD STRUCTURE ASSEMBLY

17 FRAME ASSEMBLY
18 FRAME HALF
19 FRAME
20 FRAME
21 FRAME ASSEMBLY
22 FITTING, STATION 116.500
23 PIN
24 FITTING,CENTER FIN
25 FITTING,CENTER FIN,FRONT
26 DOUBLER
27 BOLT
28 BOLT
29 SPACER (FINS 3 & 4 ONLY)
30 SPLICE
31 STRIP
32 BOLT
33 BOLT
34 NAME PLATE
35 DOUBLER
36 DOUBLER



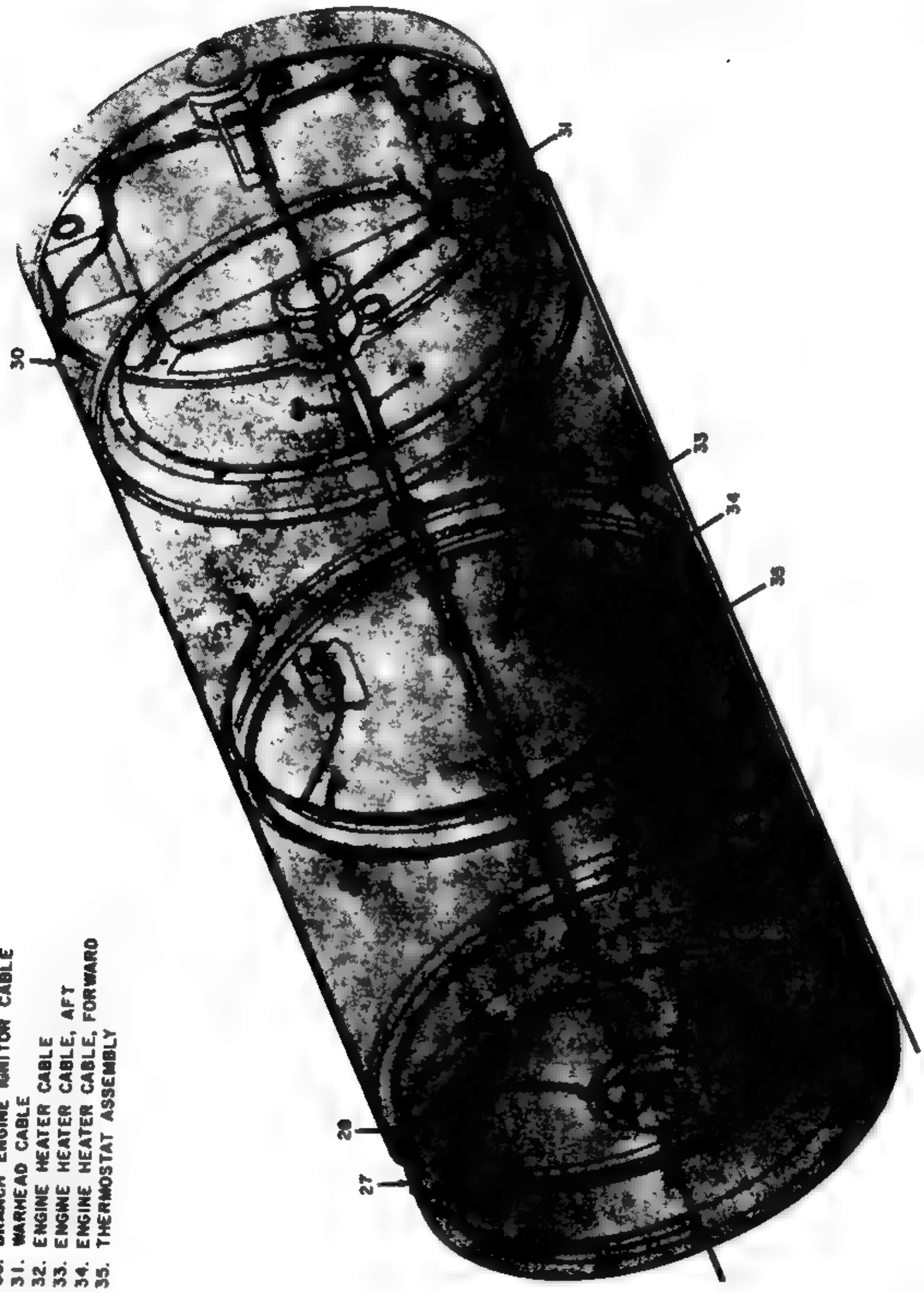
1. DOOR, THERMOSTAT ACCESS
2 DOOR
3. DOOR
4. SKIN
5 SKIN
6. SUPPORT, CABLE, FIN # 4 FORWARD
7 SUPPORT, CABLE, FIN # 4 AFT
8. SUPPORT, CABLE, FIN # 3 FORWARD
9. SUPPORT, CABLE, FIN # 3 AFT
10. BOOT, SEALING, FINS # 3 & # 4
11 BOOT, SEALING, FINS # 1 & # 2
12. PLUG
13. PLUG, HOIST POINT
14 COVER
15. SPACER FORWARD
16. SPACER AFT

ENGINE SECTION ASSEMBLY



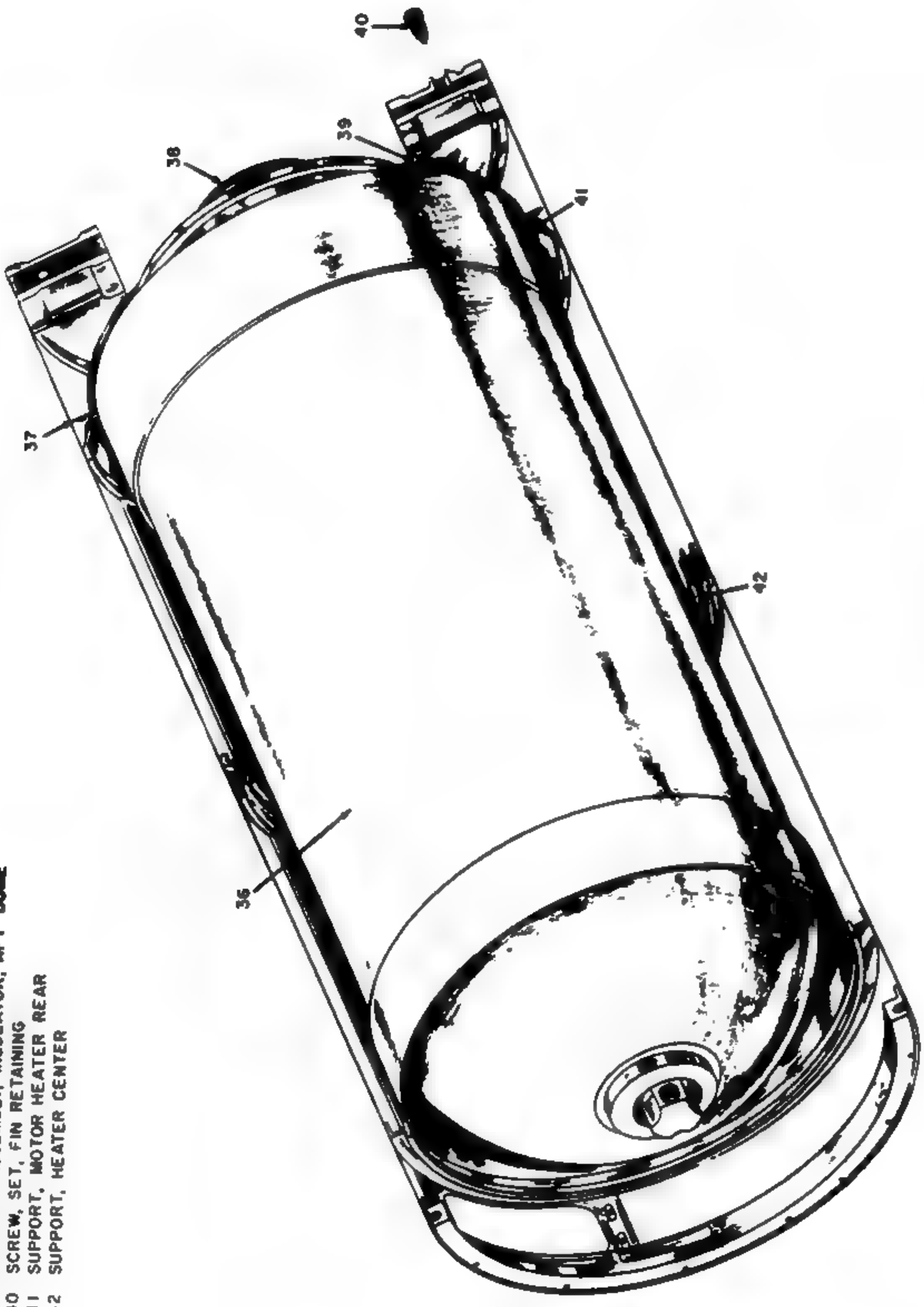
17. CAP ASSEMBLY
18. HEATER & INSULATION ASSEMBLY, FORWARD DOME
19. INSULATOR, PANEL AFT
20. INSULATOR, PANEL FORWARD
21. INSULATOR, ACCESS PANEL FORWARD
22. HEATER ASSEMBLY, SIDE PANEL
23. HEATER ASSEMBLY, SIDE PANEL
24. HAT SECTION, FORWARD
25. HAT SECTION, AFT
26. FRAME

ENGINE HEATER INSTALLATION



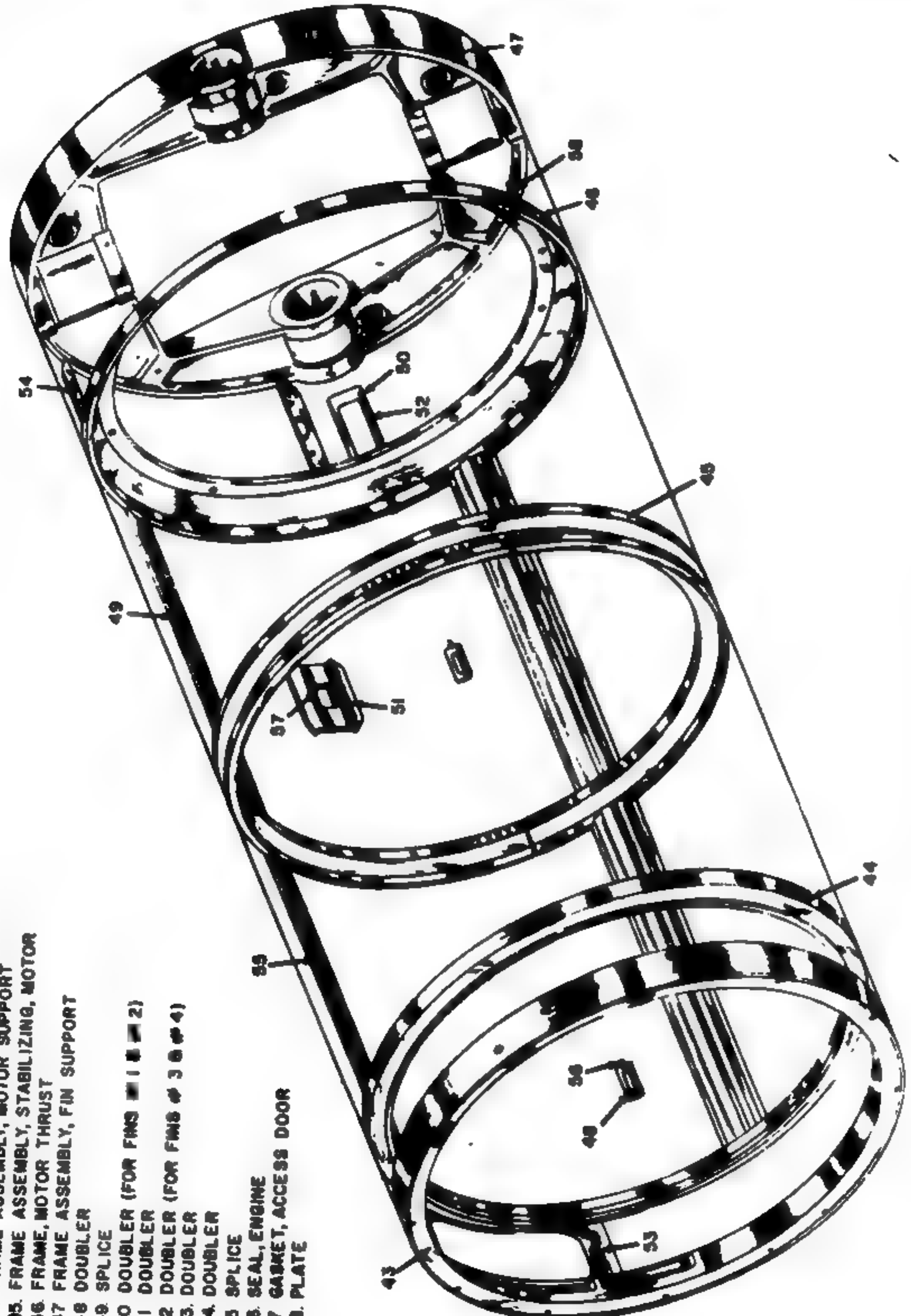
27. SAFETY & ARMING SWITCH
28. ENGINE IGNITOR CABLE
29. GUIDANCE CABLE
30. BRANCH ENGINE IGNITOR CABLE
31. WARHEAD CABLE
32. ENGINE HEATER CABLE
33. ENGINE HEATER CABLE, AFT
34. ENGINE HEATER CABLE, FORWARD
35. THERMOSTAT ASSEMBLY

ENGINE EQUIPMENT INSTALLATION



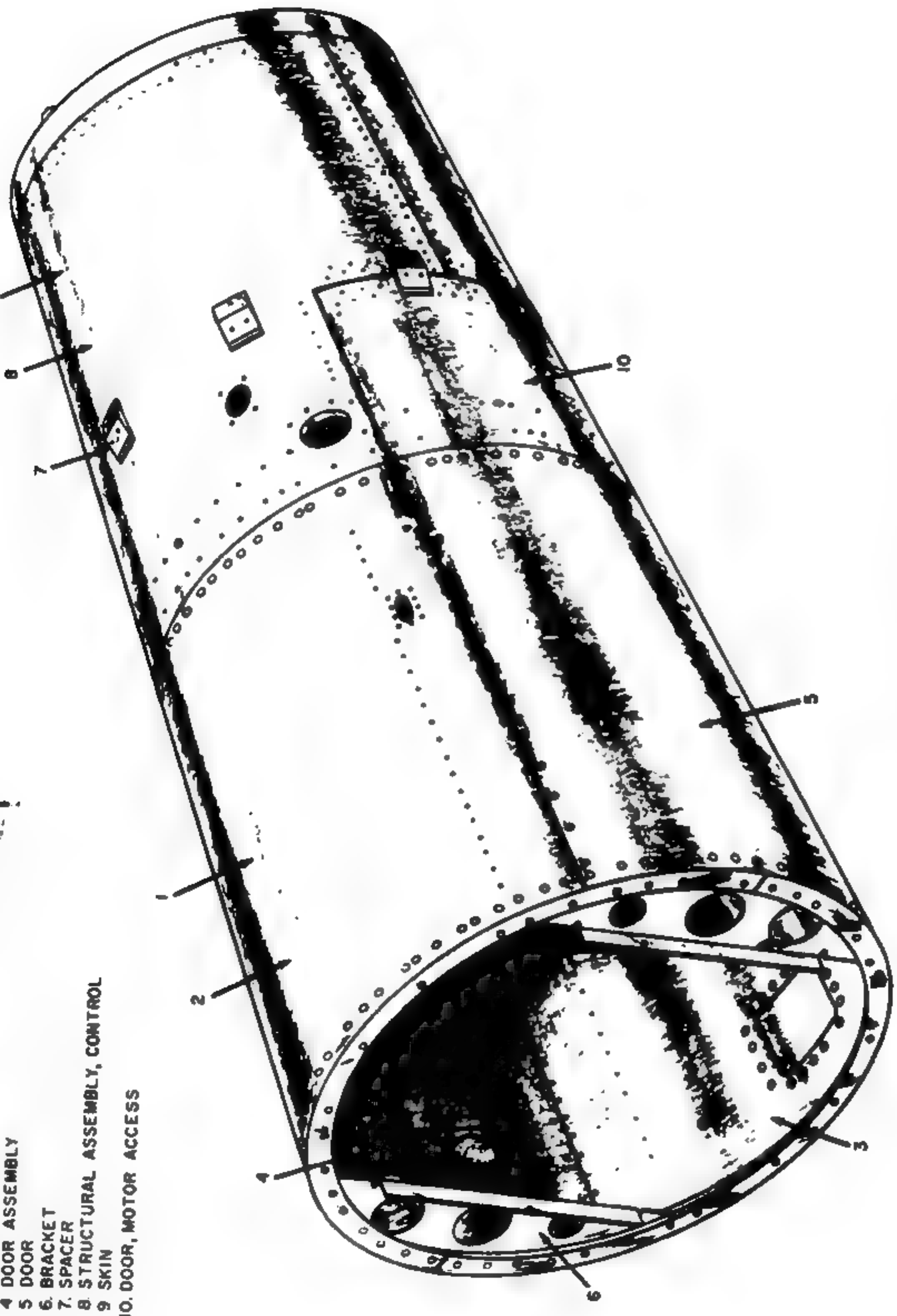
36 ROCKET MOTOR
37. BRACKET ASSEMBLY, AFT DOME
38 ADAPTER
39 SUPPORT ASSEMBLY, INSULATOR, AFT DOME
40 SCREW, SET, FIN RETAINING
41 SUPPORT, MOTOR HEATER REAR
42 SUPPORT, HEATER CENTER

CASE AND ADAPTER ASSEMBLY INSTALLATION



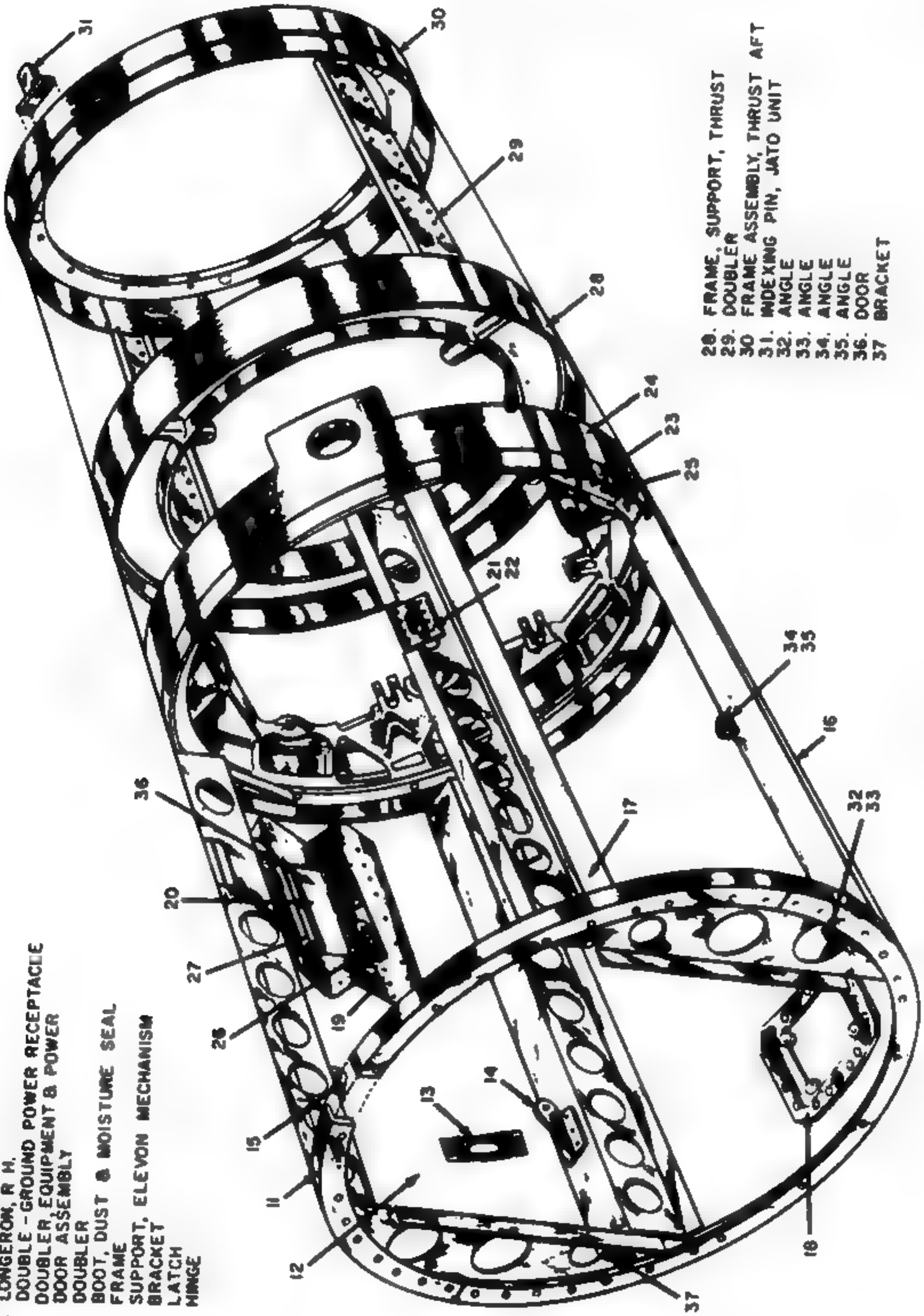
43. FRAME ASSEMBLY, FORWARD MOTOR SECTION
44 FRAME ASSEMBLY, MOTOR SUPPORT
45. FRAME ASSEMBLY, STABILIZING, MOTOR
46. FRAME, MOTOR THRUST
47 FRAME ASSEMBLY, FIN SUPPORT
48 DOUBLER
49. SPLICE
50 DOUBLER (FOR FINS # 1 & # 2)
51 DOUBLER
52 DOUBLER (FOR FINS # 3 & # 4)
53. DOUBLER
54. DOUBLER
55 SPLICE
56. SEAL, ENGINE
57 GASKET, ACCESS DOOR
58. PLATE

ENGINE STRUCTURE ASSEMBLY



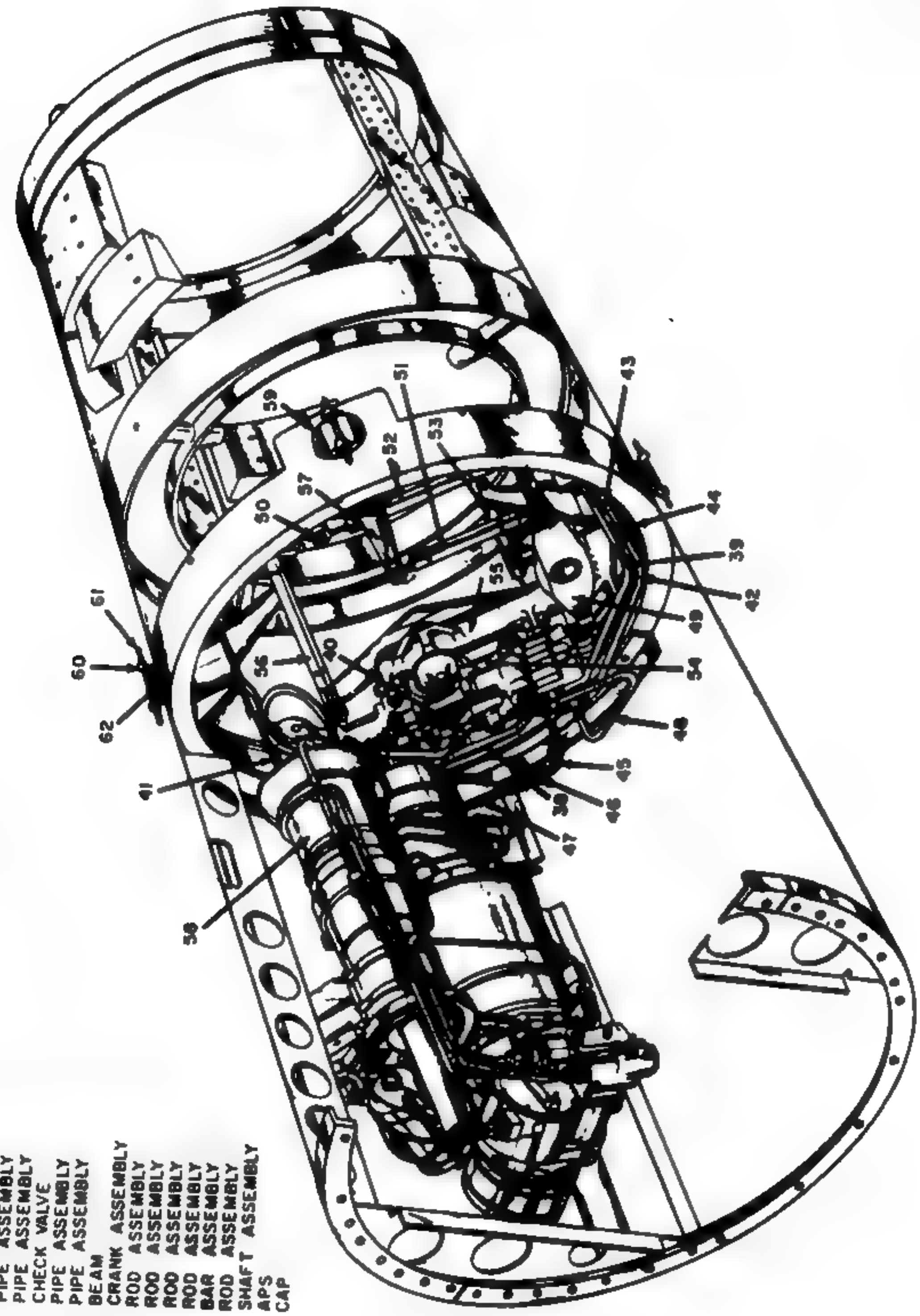
EQUIPMENT AND CONTROL SECTION ASSEMBLY

1. STRUCTURAL ASSEMBLY, EQUIPMENT & POWER
2. SKIN TOP
3. SKIN BOTTOM
4. DOOR ASSEMBLY
5. DOOR
6. BRACKET
7. SPACER
8. STRUCTURAL ASSEMBLY, CONTROL
9. SKIN
10. DOOR, MOTOR ACCESS



11. FRAME
12. DOOR ASSEMBLY
13. SEAL, EXHAUST
14 BRACKET
15. BRACKET
16. LONGERON, L.H
17. LONGERON, R.H.
18 DOUBLE -GROUND POWER RECEPTACLE
19. DOUBLER, EQUIPMENT & POWER
20. DOOR ASSEMBLY
21. DOUBLER
22. BOOT, DUST & MOISTURE SEAL
23. FRAME
24 SUPPORT, ELEVON MECHANISM
25. BRACKET
26. LATCH
27. HINGE
28. FRAME, SUPPORT, THRUST
29. DOUBLER
30 FRAME ASSEMBLY, THRUST AFT
31. INDEXING PIN, JATO UNIT
32. ANGLE
33. ANGLE
34. ANGLE
35. ANGLE
36. DOOR
37 BRACKET

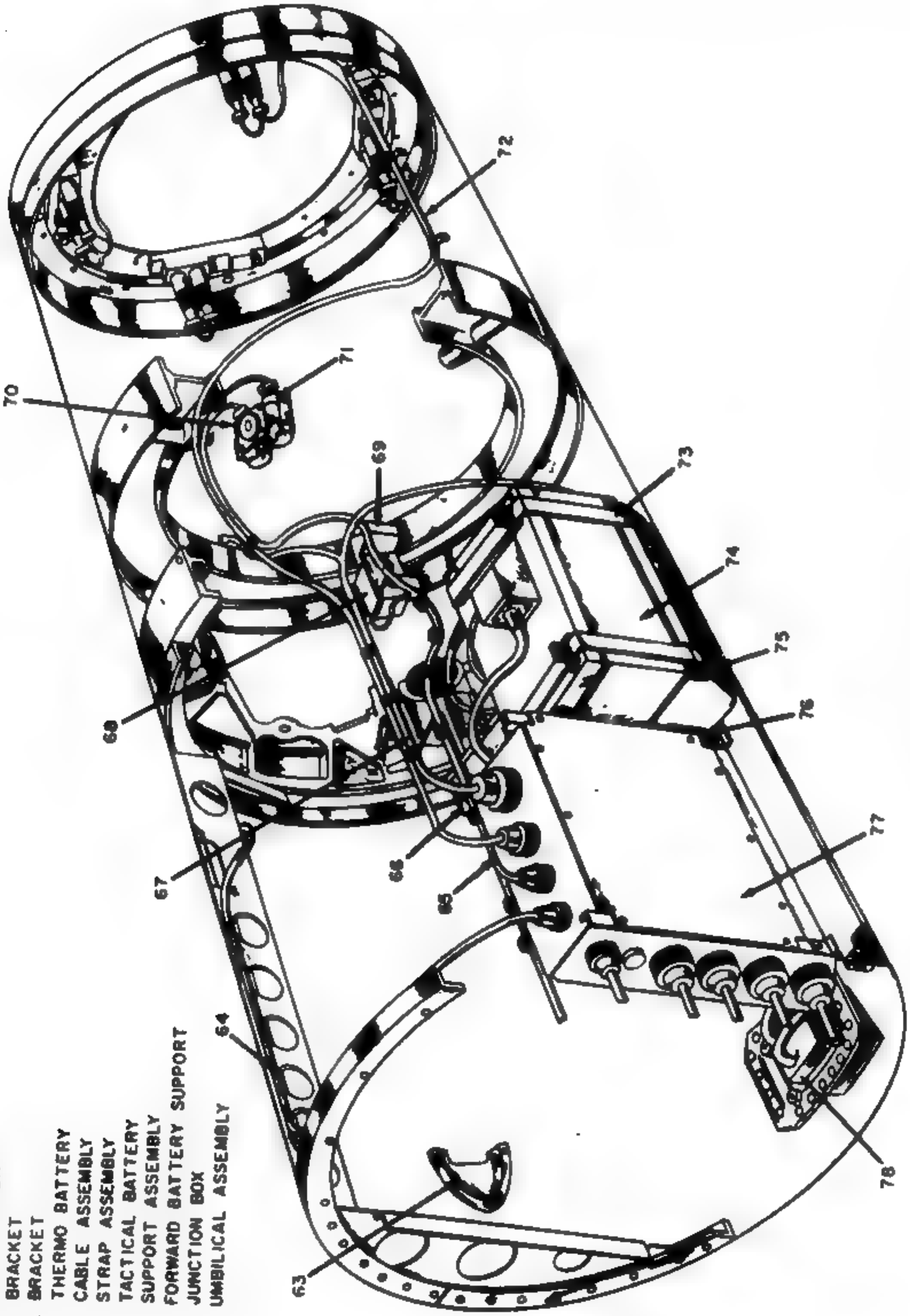
EQUIPMENT AND CONTROL STRUCTURE ASSEMBLY



HYDRAULIC CONTROL INSTALLATION

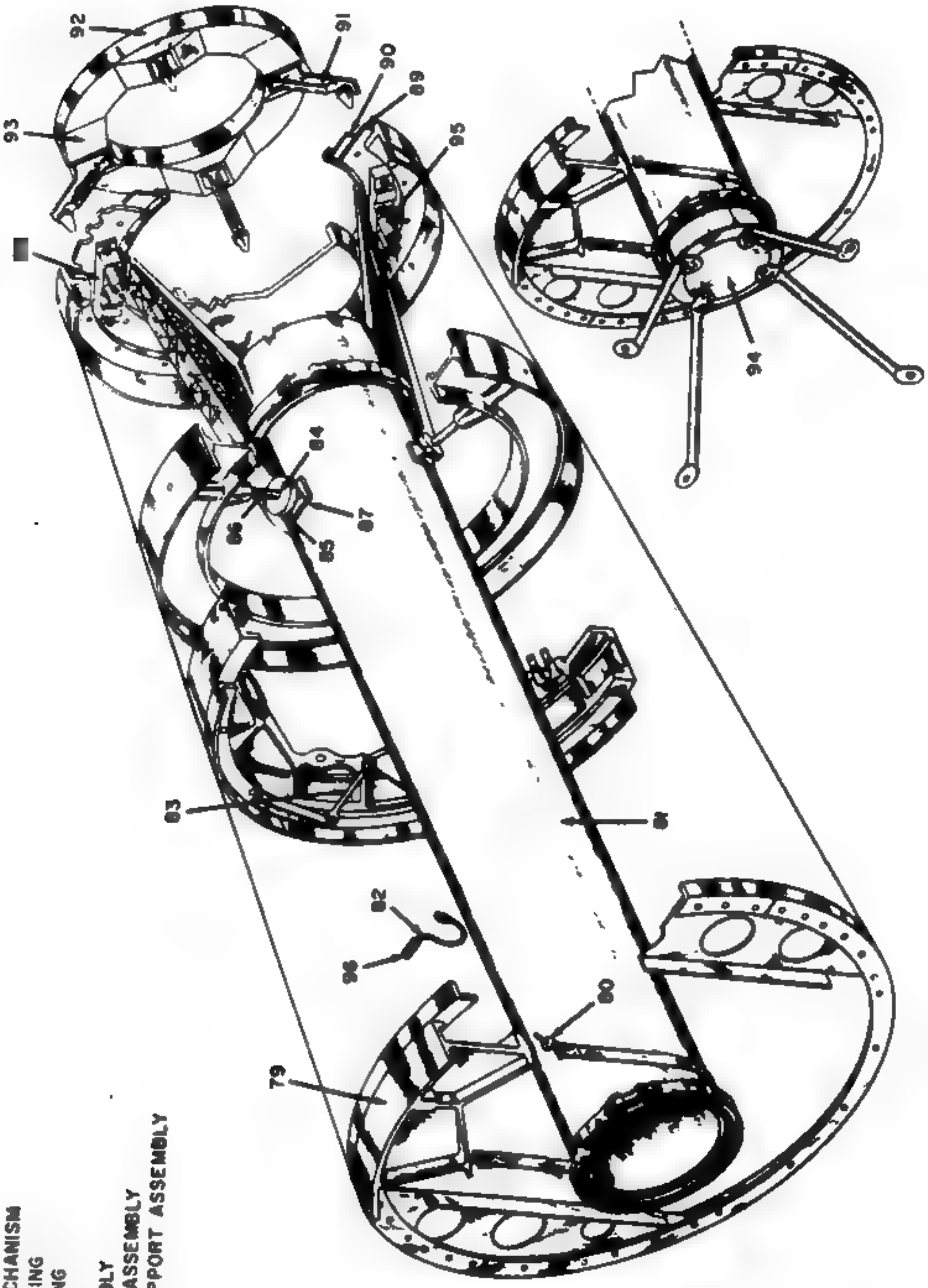
38. PIPE ASSEMBLY
39. PIPE ASSEMBLY
40. PIPE ASSEMBLY
41. PIPE ASSEMBLY
42 PIPE ASSEMBLY
43 PIPE ASSEMBLY
44 PIPE ASSEMBLY
45. PIPE ASSEMBLY
46 CHECK VALVE
47 PIPE ASSEMBLY
48 PIPE ASSEMBLY
49 BEAM
50. CRANK ASSEMBLY
51. ROD ASSEMBLY
52. ROD ASSEMBLY
53. ROD ASSEMBLY
54. ROD ASSEMBLY
55. BAR ASSEMBLY
56. ROD ASSEMBLY
57. SHAFT ASSEMBLY
58. APS
59 CAP

60. UNIVERSAL JOINT
61. PIN, CONTROL SURFACE ATTACHING
62 PIN



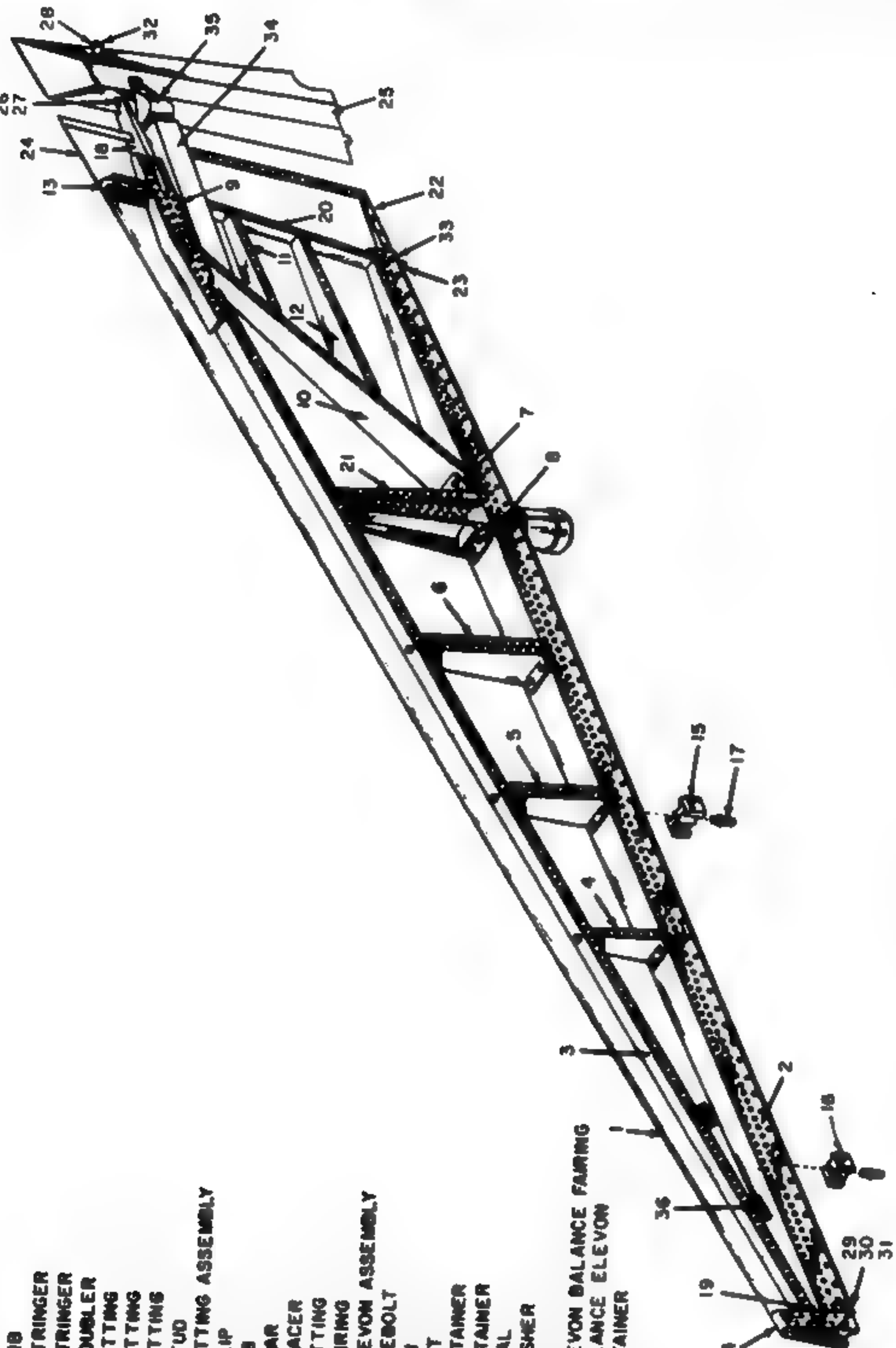
63. VENT ASSEMBLY
64. CABLE ASSEMBLY
65. CABLE ASSEMBLY
66 ZEE BAR
67. CABLE ASSEMBLY
68 DELAY TIMER
69 BRACKET
70. BRACKET
71. THERMO BATTERY
72 CABLE ASSEMBLY
73. STRAP ASSEMBLY
74. TACTICAL BATTERY
75 SUPPORT ASSEMBLY
76. FORWARD BATTERY SUPPORT
77 JUNCTION BOX
78 UMBILICAL ASSEMBLY

ELECTRICAL INSTALLATION EQUIPMENT AND CONTROL SECTION



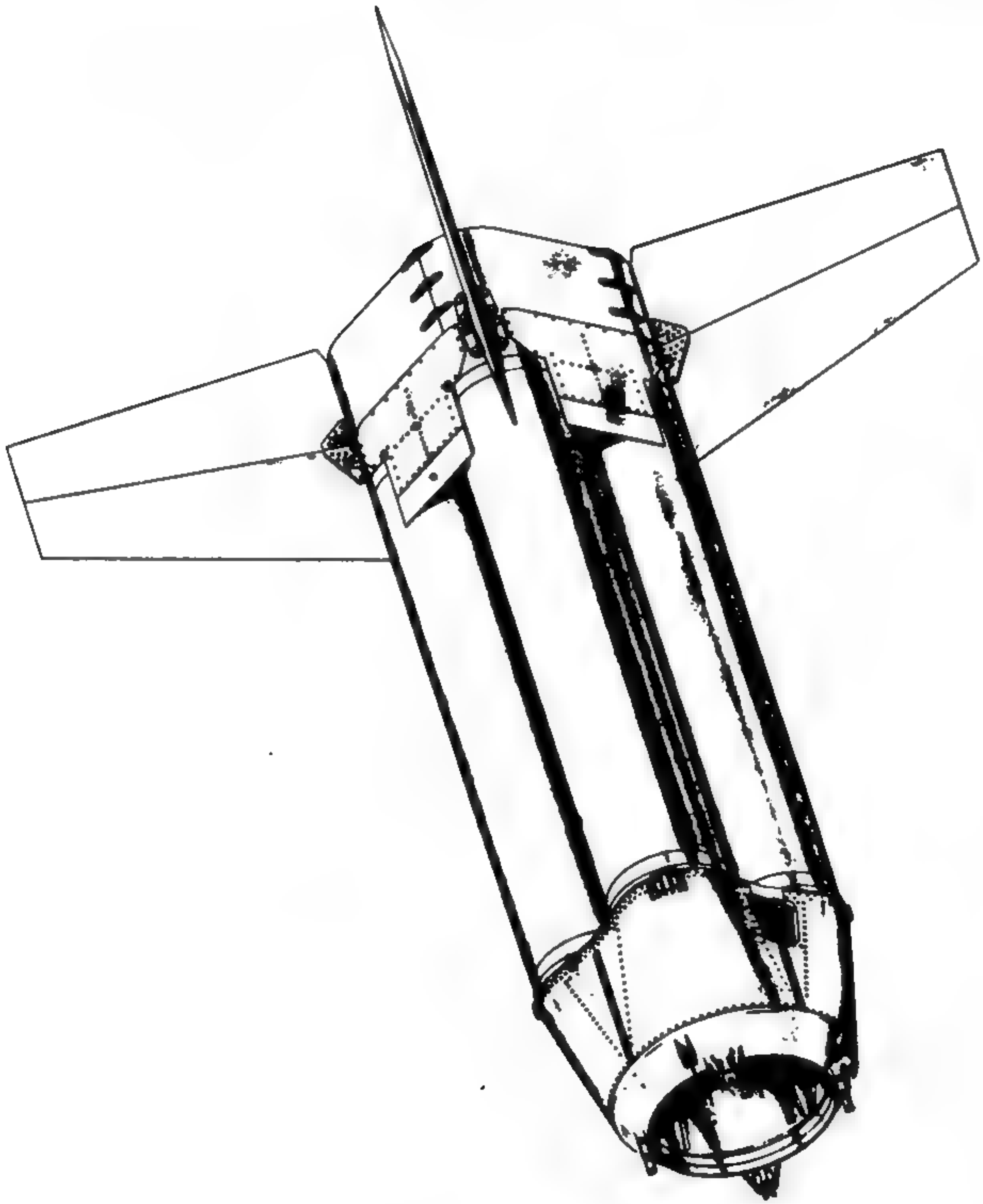
BLAST TUBE AND THRUST LIMITER INSTALLATION

79. FRAME
80. EYEBOLT
81. BLAST TUBE & NOZZLE ASSEMBLY
82. TUBE ASSEMBLY
83. LINK ASSEMBLY
84. ADJUSTING ASSEMBLY
85 KNOB
86 STUD
87 SHOE
88 ATTACH MECHANISM
89. MOUNTING RING
90. CLOSURE RING
91 SUPPORT
92 RING ASSEMBLY
93. DROPPABLE ASSEMBLY
94 SHIPPING SUPPORT ASSEMBLY
95. SQUIB
96. FITTING

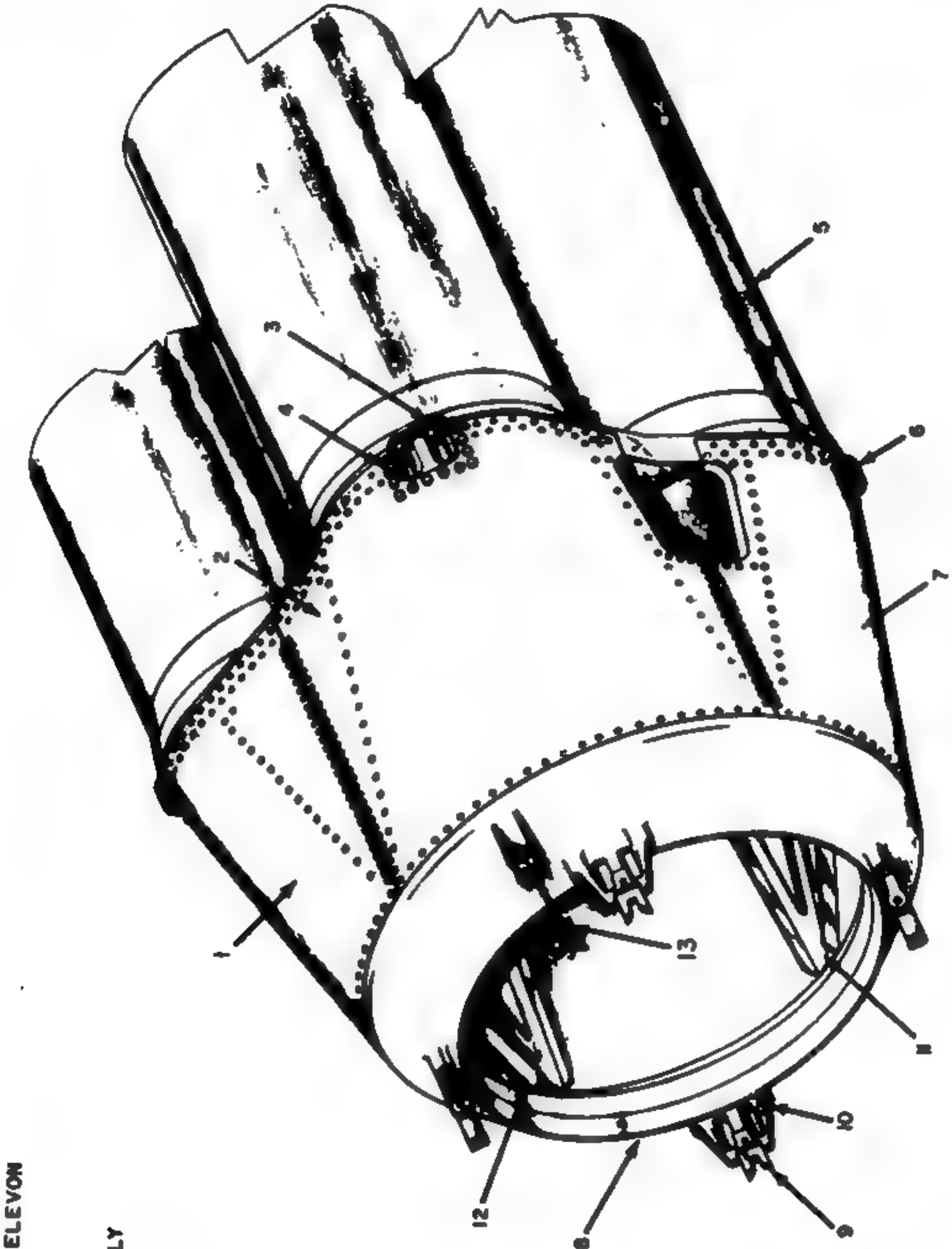


STRUCTURE ASSEMBLY, MAIN FIN AND ELEVON ASSEMBLY

1. SKIN
2. CHANNEL
3. CHANNEL
4. RIB
5. RIB
6. RIB
7. CLIP
8. CLIP
9. CLIP
10. RIB
11. STRINGER
12. STRINGER
13. DOUBLER
14. FITTING
15. FITTING
16. FITTING
17. STUD
18. FITTING ASSEMBLY
19. CLIP
20. RIB
21. SPAR
22. SPACER
23. FITTING
24. FAIRING
25. ELEVON ASSEMBLY
26. EYEBOLT
27. PIN
28. NUT
29. RETAINER
30. RETAINER
31. SEAL
32. WASHER
33. PIN
34. ELEVON BALANCE FAIRING
35. BALANCE ELEVON
36. RETAINER

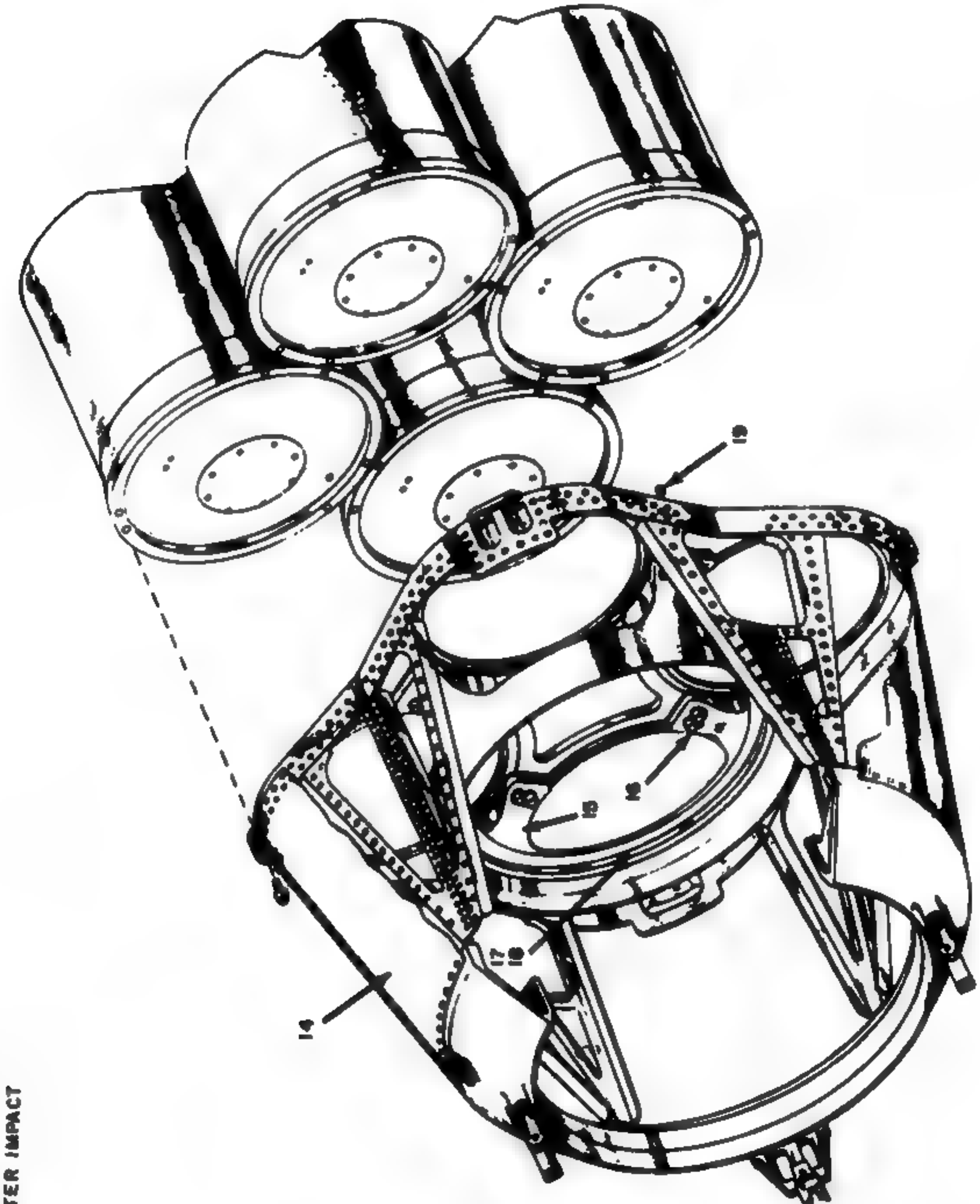


BOOSTER GENERAL ASSEMBLY



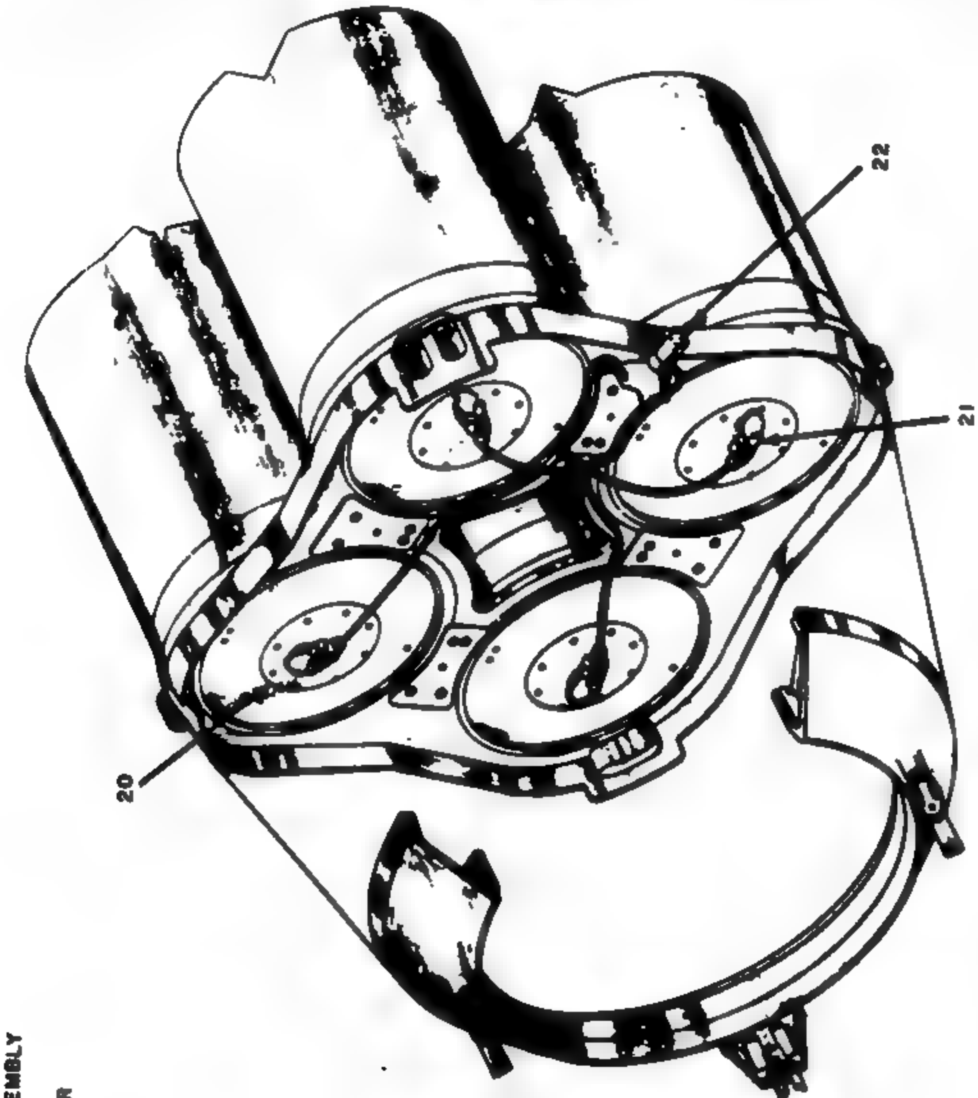
BOOSTER THRUST STRUCTURE

1. SKIN, BOOSTER THRUST
2. SKIN
3. BOLT
4. BOLT
5. JATO M5E1, LOADING ASSEMBLY
6. BASE PLATE
7. THRUST ASSEMBLY
8. RING
9. LOCK ASSEMBLY, ELEVON
10. BOLT
11. SPLICE
12. DOUBLER
13. LANYARD ASSEMBLY



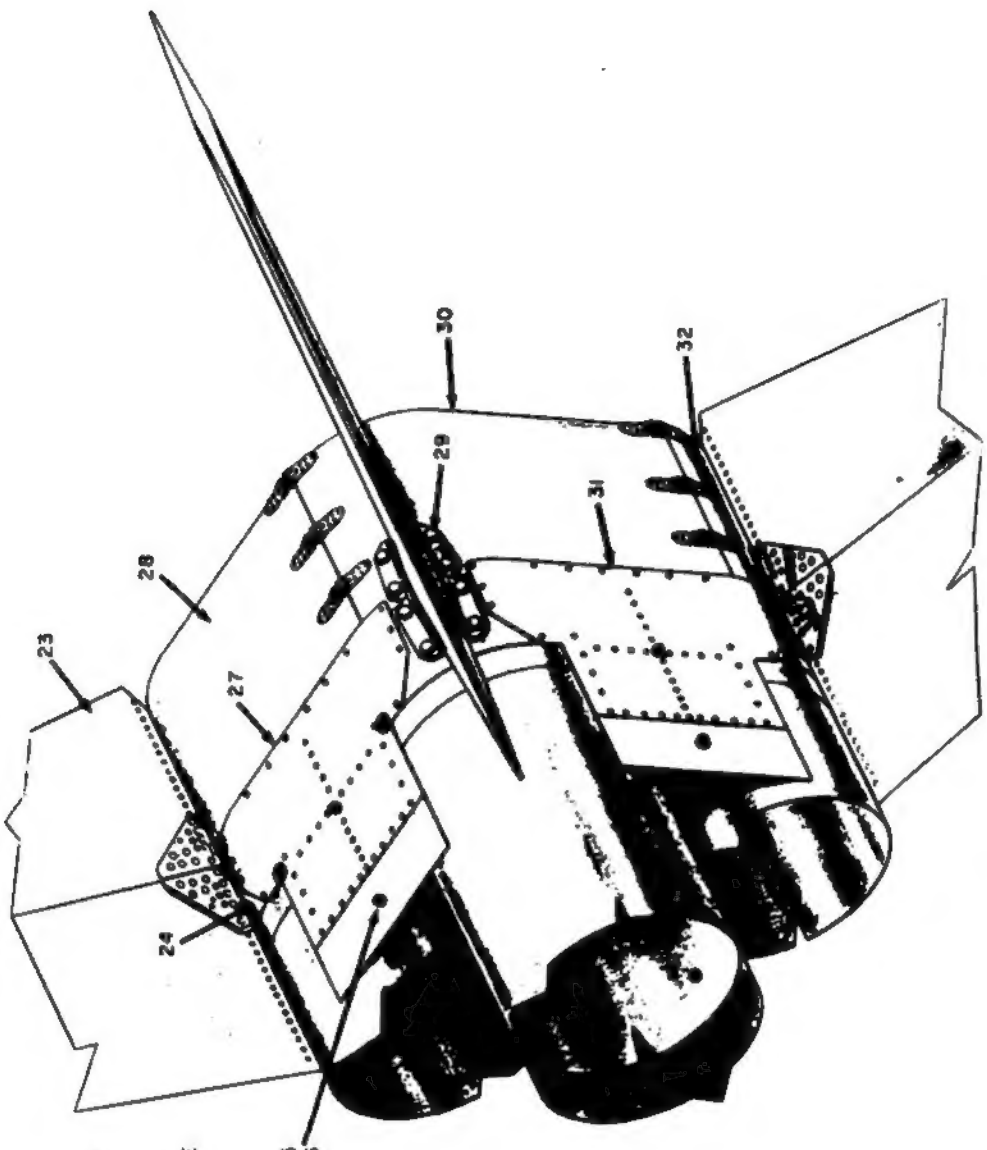
BOOSTER THRUST STRUCTURE CUTAWAY

14. FITTING ASSEMBLY
15. PEDESTAL
16. BOLT
17. CUSHION, BOOSTER IMPACT
18. CUSHION, BOOSTER IMPACT
19. BOLT



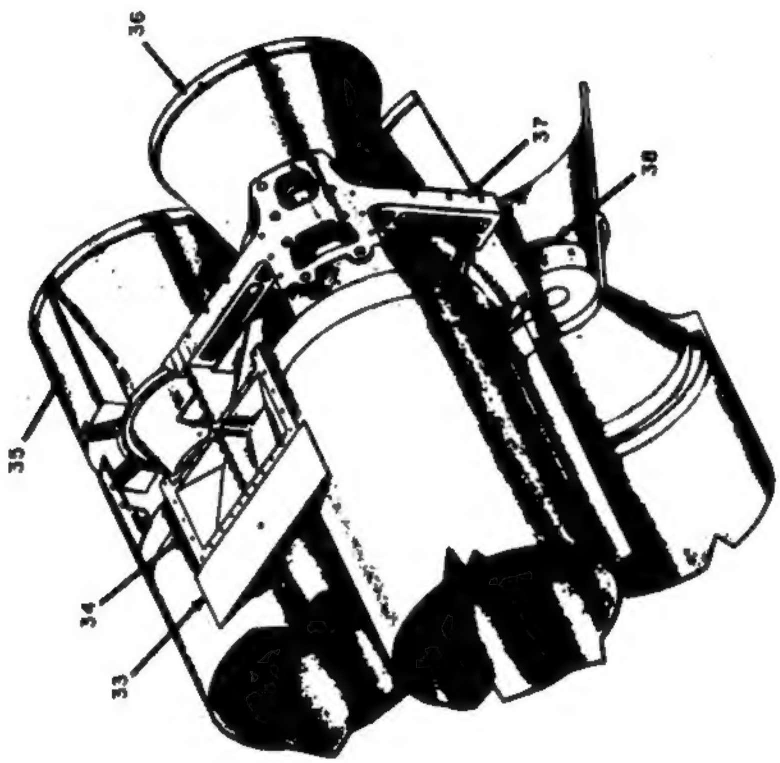
BOOSTER IGNITOR HARNESS

20. IGNITOR, JATO, ELECTRIC, M24 ASSEMBLY
21. HARNESS ASSEMBLY
22. CABLE ASSEMBLY, BOOSTER IGNITOR



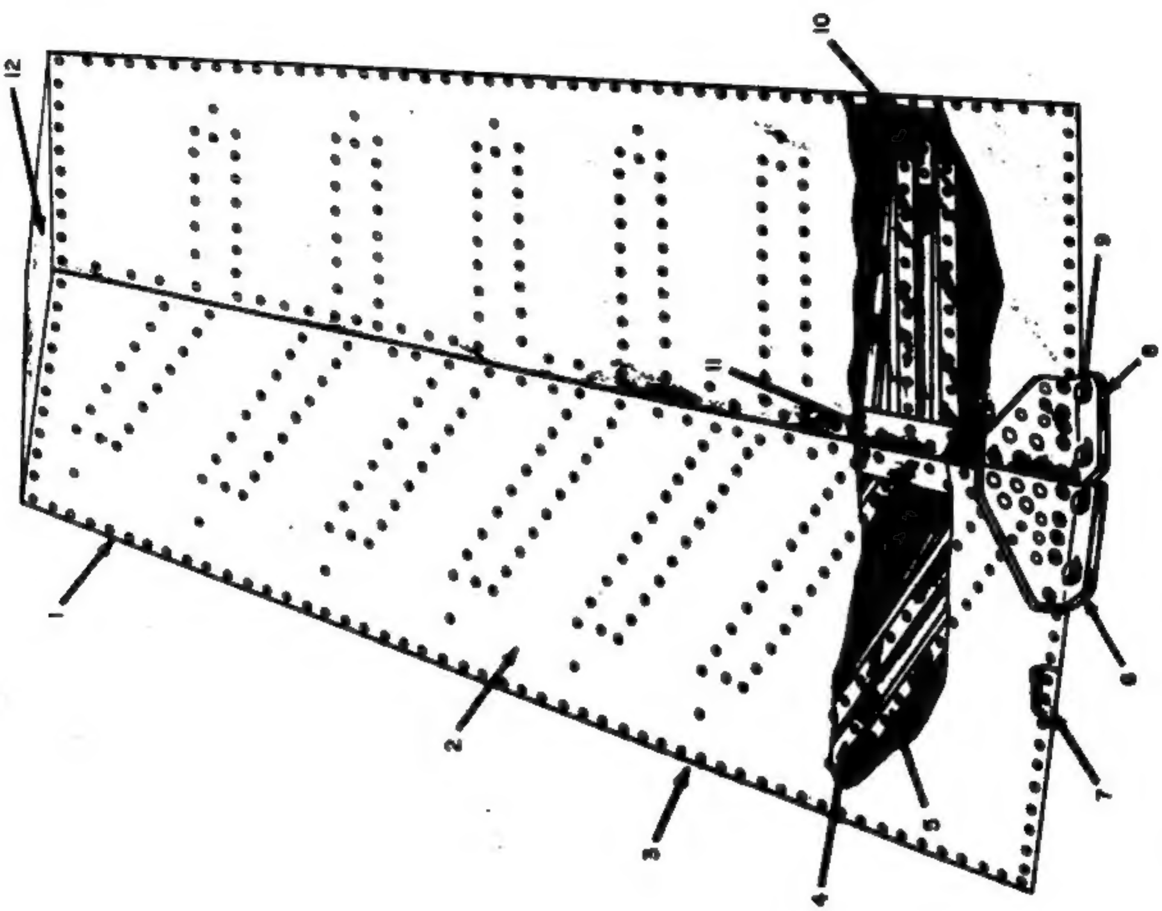
23. FIN ASSEMBLY
24. FAIRING
25. BOLT
26. NUT
27. FAIRING ASSEMBLY, BOOSTER TOP
28. FAIRING
29. BOLT
30. FAIRING
31. FAIRING ASSEMBLY, BOOSTER SIDE
32. FAIRING

BOOSTER FIN AND FAIRINGS



BOOSTER FAIRING AND NOZZLE CUTAWAY

33. WEDGE
34. FITTING
35. FILLER BLOCK
36. JATO M5E1, LOADING ASSEMBLY
37. FITTING ASSEMBLY
38. CLOSURE, NOZZLE ASSEMBLY



BOOSTER FIN ASSEMBLY

1. FIN ASSEMBLY
2. SKIN (LEFT SIDE)
3. SKIN (RIGHT SIDE)
4. SPACER
5. RIB
6. ANGLE AND OPPOSITE HAND PART
7. RIB (CLOSING, INBOARD)
8. ANGLE AND OPPOSITE HAND PART
9. BOLT
10. SPACER
11. SPAR
12. RIB (CLOSING, OUTBOARD)

BELL TELEPHONE LABORATORIES
BELL SYSTEM
INCORPORATED